

**PRELIMINARY FINDINGS
OF THE
LIGHTNING INCIDENT
DURING THE APOLLO 12 LAUNCH**

WEATHER OBSERVATIONS

- NO THUNDERSTORMS IN THE AREA
 - RADAR OBSERVATION
 - POTENTIAL GRADIENT RECORDINGS
 - CLOUD FORMATIONS
- CLOUDS ESTIMATE
 - 800 FEET - BROKEN
 - 10,000 FEET - OVERCAST
 - TOPS ABOUT 21,000
- VISIBILITY 7 MILES
- LIGHT RAIN SHOWERS
- TEMP 70° F DEWPOINT 66° F
- PRESSURE 29.69 INCHES

APOLLO 12 LAUNCH, NOVEMBER 14, 1969

LIGHTNING, PAD A VICINITY

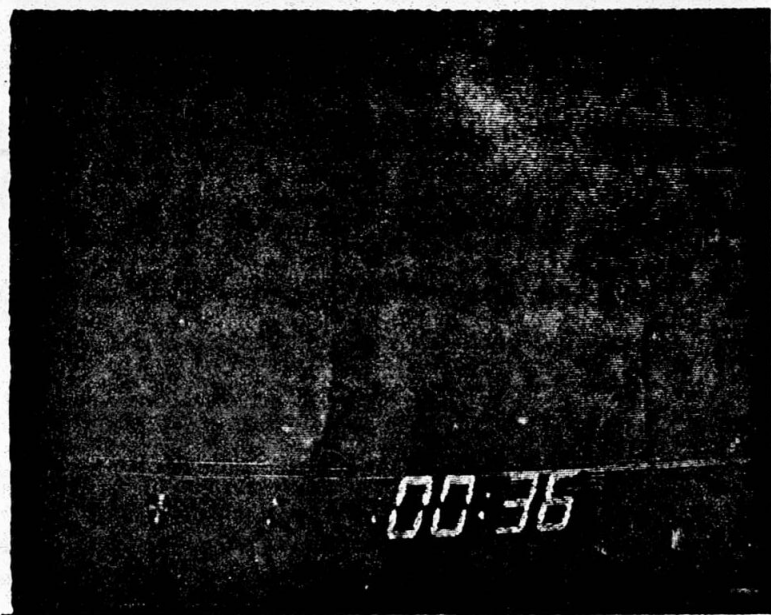
CAMERA LOOKING APPROXIMATELY DUE EAST FROM

CAMERA SITE 5 (PERIMETER) - ABORT ADVISORY CAMERA NO. 4

INDIVIDUAL EXPOSURES 1/30 SEC, SEPARATED BY 0.001 SECONDS

BETWEEN EXPOSURES. EXPOSURES ARE SEQUENTIAL, AS TAKEN

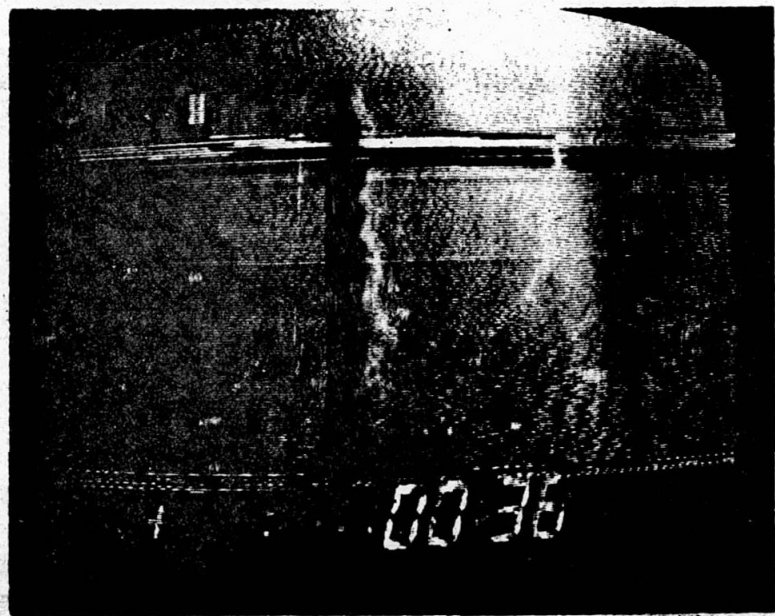
ON VIDEO TAPE - 11:32:36 AM EST



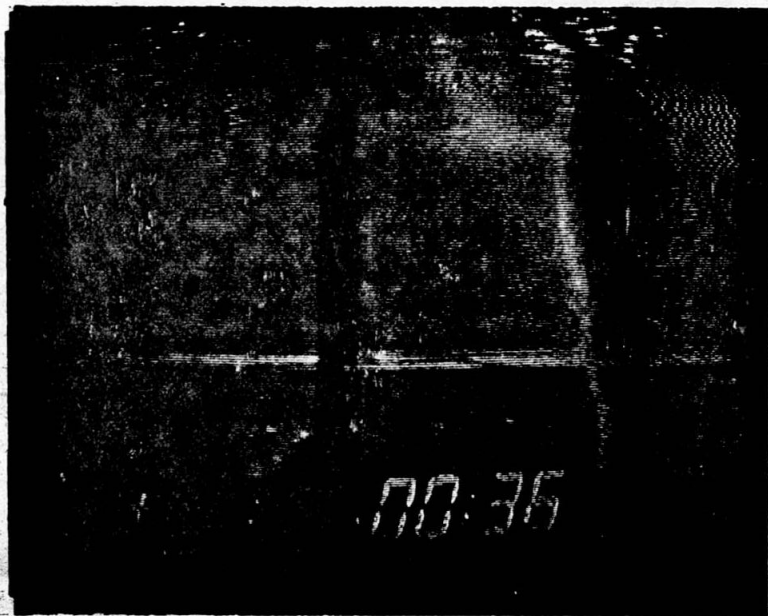
1



3



2



4



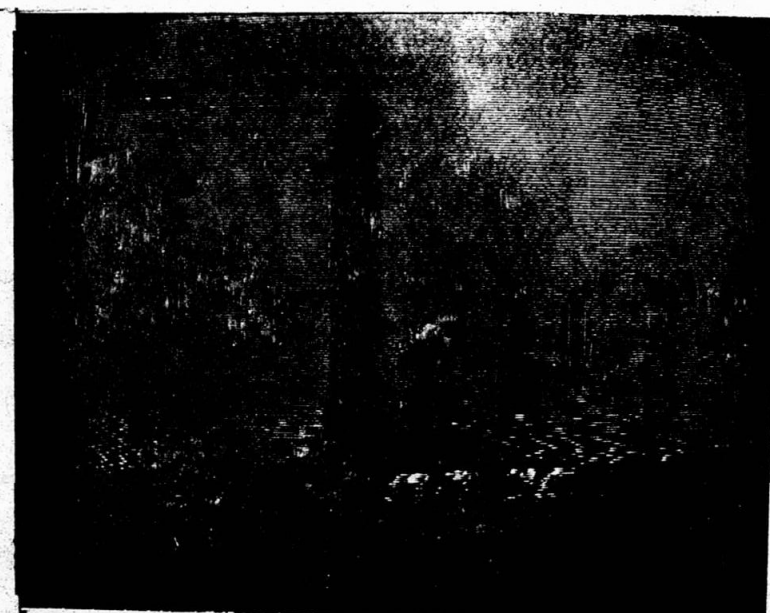
5



7

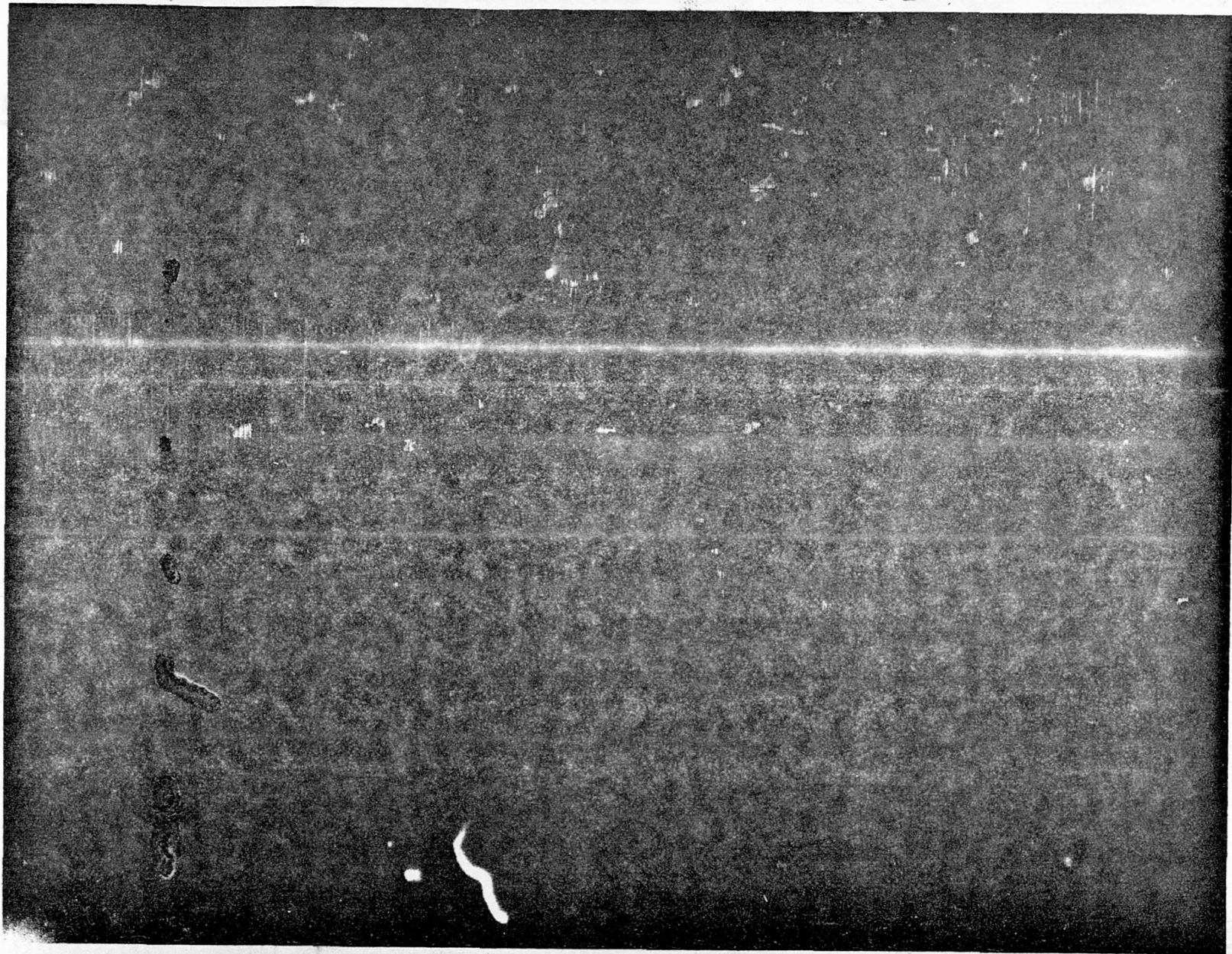


6



8

NASA
8-09-59234

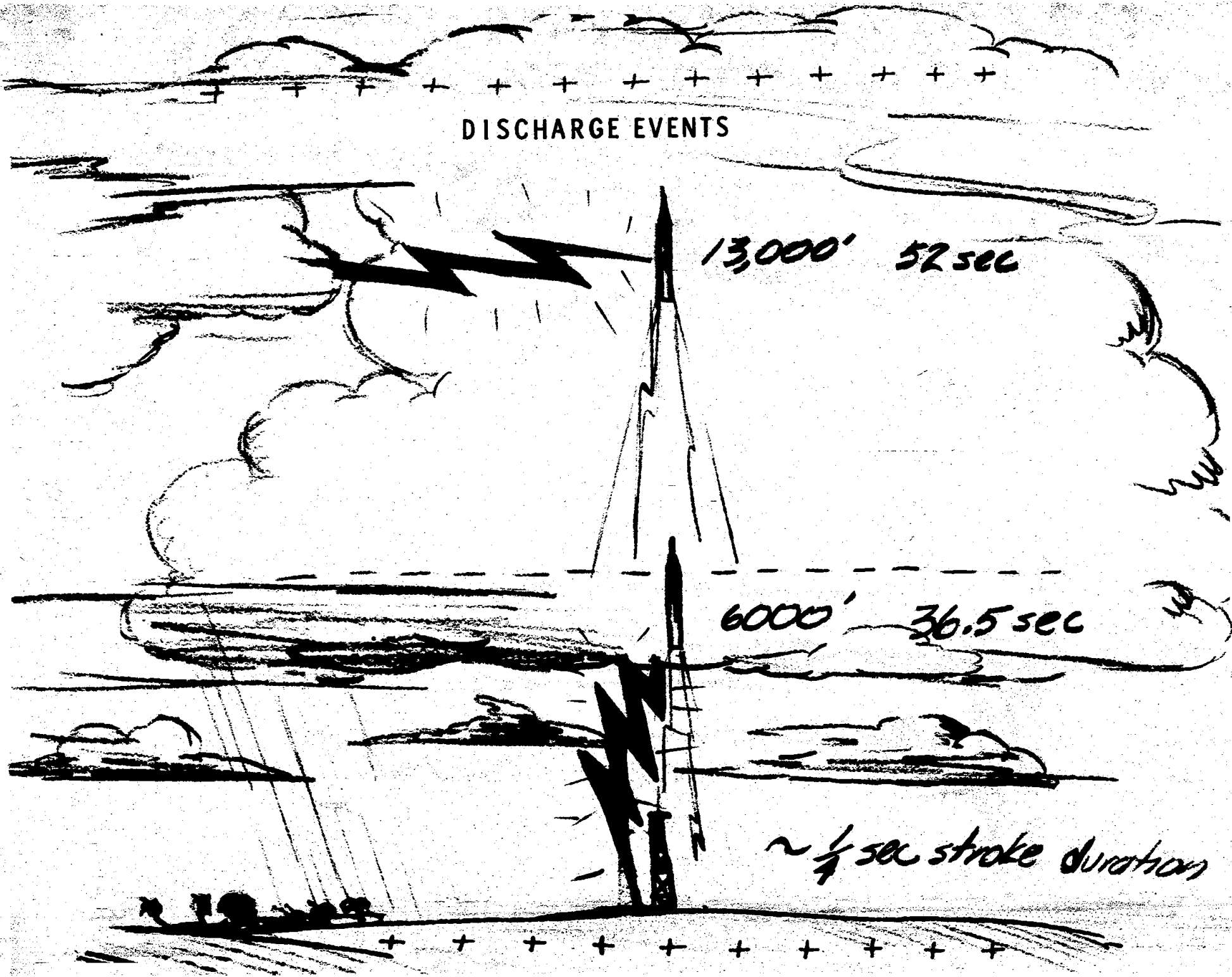


DISCHARGE EVENTS

13,000' 52 sec

6000' 36.5 sec

$\sim \frac{1}{4}$ sec stroke duration



OBSERVED CONDITIONS

~36 SEC

- LIGHTNING STRIKE BETWEEN CLOUD BASE AND GROUND
- CREW SAW BRIGHT LIGHT

36.5 SEC

- FUEL CELLS DISCONNECTED FROM BUS
- NUMEROUS ALARMS AND WARNING LIGHTS IN CABIN
- SIGNAL CONDITIONING EQUIPMENT DROPPED OUT
(90 SEC RETURNED)
- 4 TEMP MEASUREMENTS OUT
- 4 PROPELLANT QUANTITY GAGING MEASUREMENTS OUT
- 1 TEMP MEASUREMENT OF THE NUCLEAR PARTICLE
DETECTION OUT
- IU, S-IVB, AND S-II TRANSIENTS ON SEVERAL
MEASUREMENTS

OBSERVED CONDITIONS (CONT)

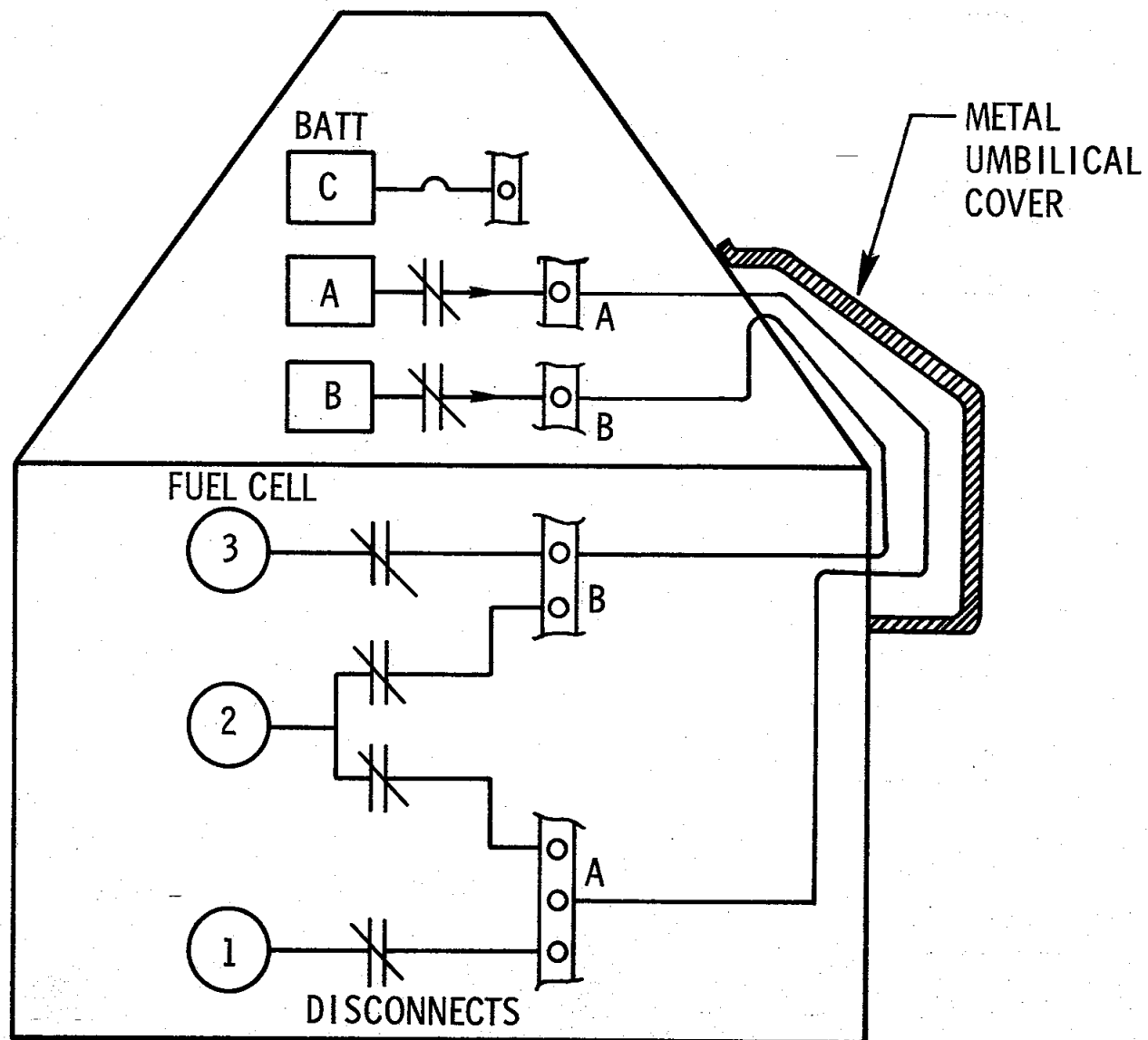
52 SEC

- 4 MESSAGE ACCEPTANCE PULSES
- CENTRAL TIMING EQUIPMENT RESET TWICE -
AND CHANGED PULSE RATE
- INERTIAL MEASUREMENT UNIT TUMBLED
- LAUNCH VEHICLE CURRENT SPIKE (IU)

POTENTIAL DISCHARGE EFFECT ON VEHICLE

- INDUCTION INTO WIRING-DEPENDENT ON WIRE LOCATION AND RATE OF CHANGE OF POTENTIAL
- DIRECT CURRENT FLOW IN GROUNDING

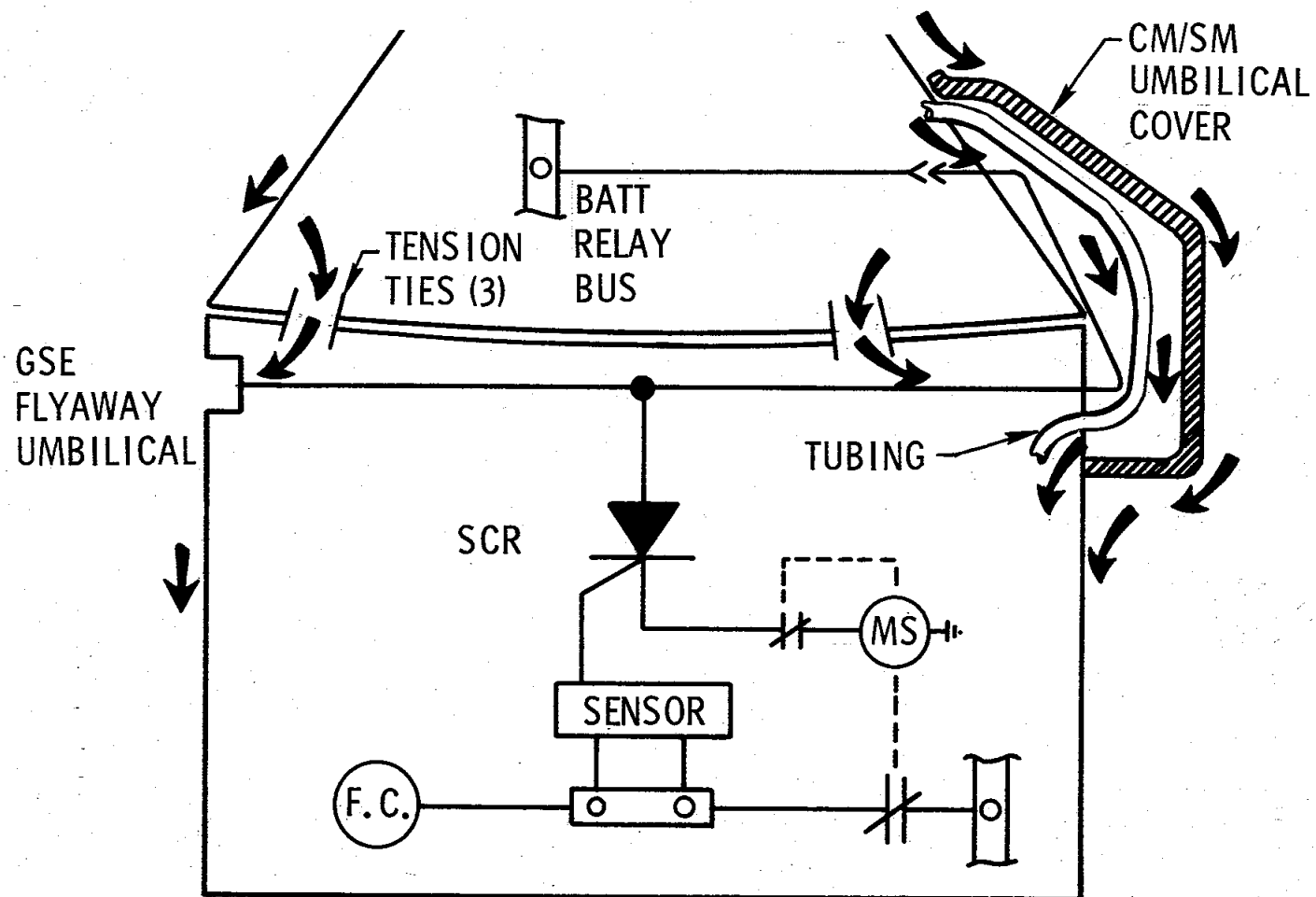
SPACECRAFT DC POWER SYSTEM



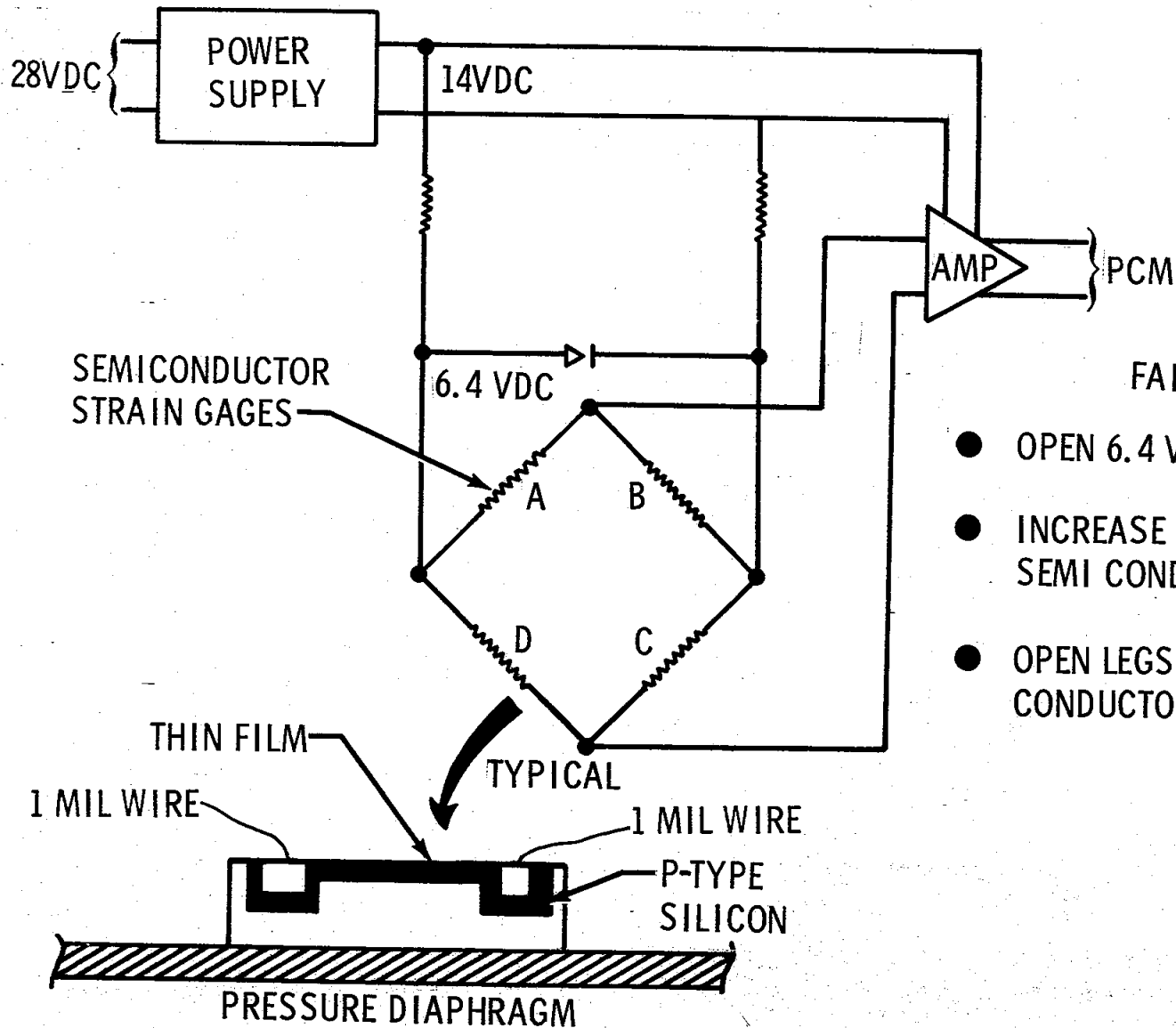
T + 36.5 - SECOND POWER SYSTEM SEQUENCE OF EVENTS

- FUEL CELLS DISCONNECTED (dv/dt) (SEE NEXT DIAGRAM)
 - MAIN BUS A AND B UNDERVOLTAGE (26.25v dc)
 - SCE OFF (22.9v dc)
 - MOMENTARY DROP IN AC VOLTAGE (16v dc)
 - AC BUS 1 AND 2 FAIL (95v ac)
- AC OVERLOAD (dv/dt)

BUS DISCONNECT CIRCUIT AND CURRENT FLOW PATHS DURING DISCHARGE



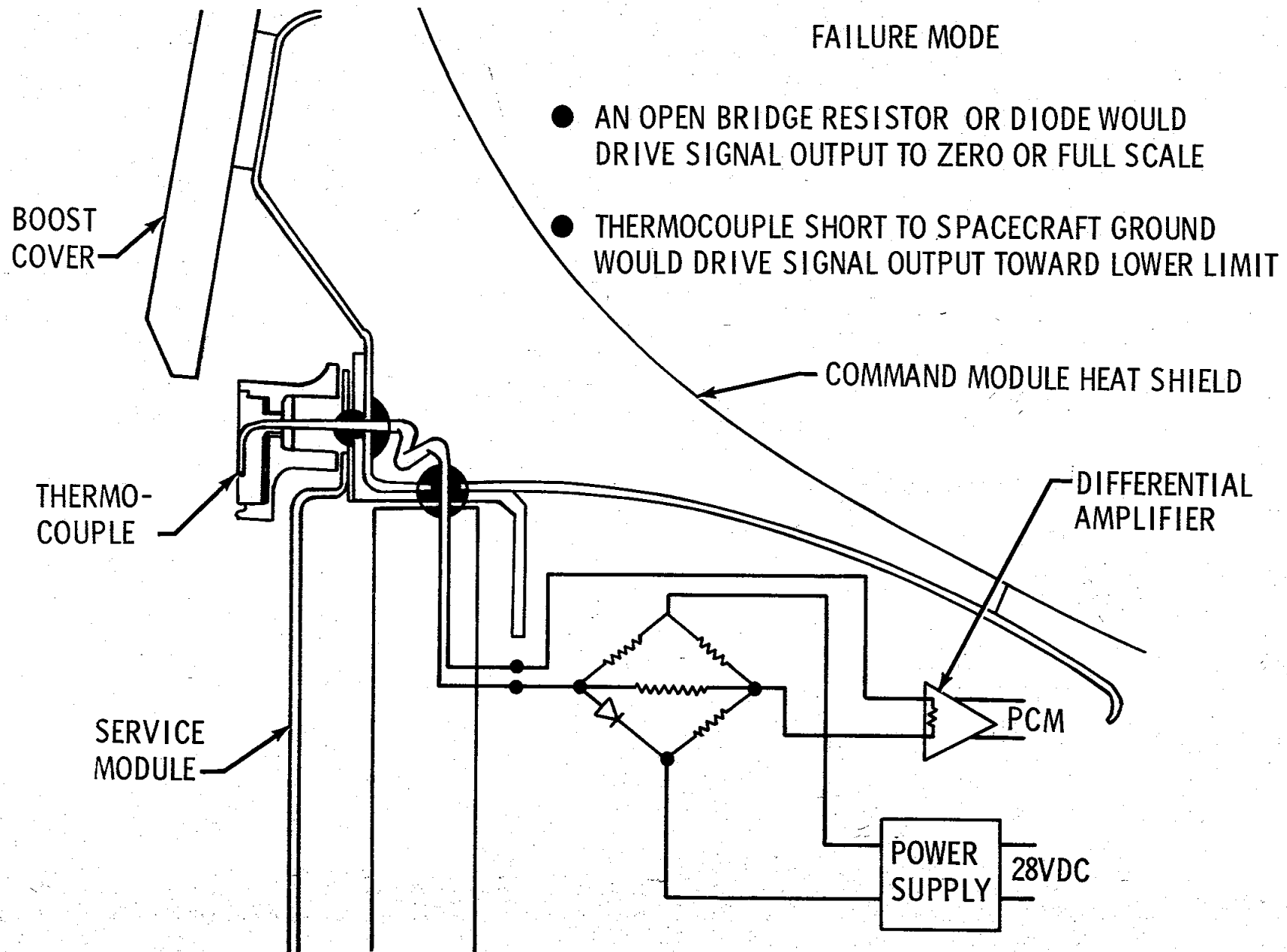
FOUR REACTION CONTROL HELIUM TANK QUANTITY (P/T RATIO)
CIRCUIT FAILURES AT 36.5 SECONDS (TYPICAL ONE SHOWN)



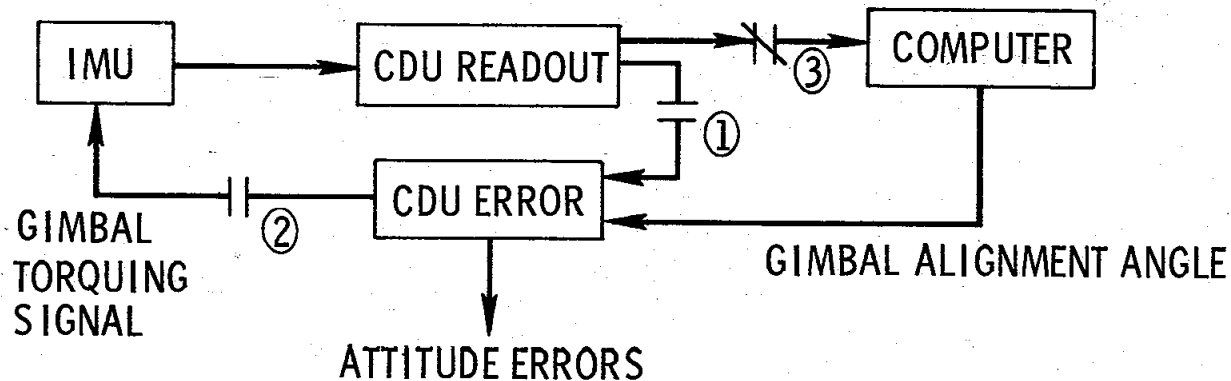
FAILURE MODES

- OPEN 6.4 VDC ZENNER DIODE
- INCREASE IN THIN FILM BRIDGE SEMI CONDUCTOR STRAIN GAGES
- OPEN LEGS (B OR D) OF SEMI CONDUCTOR BRIDGE

4 THERMOCOUPLES (TYPICAL ONE SHOWN)



52 SECOND IMU TUMBLE SIMPLIFIED FUNCTIONAL DIAGRAM



CDU READOUT OF MIDDLE GIMBAL JUMPED TO OVER 85°

- 85° READOUT CAUSED CMC TO CLOSE SWITCHES 1 AND 2
(GO TO COURSE ALIGN) (NORMALLY IN COURSE ALIGN "SWITCH 3" OPEN)

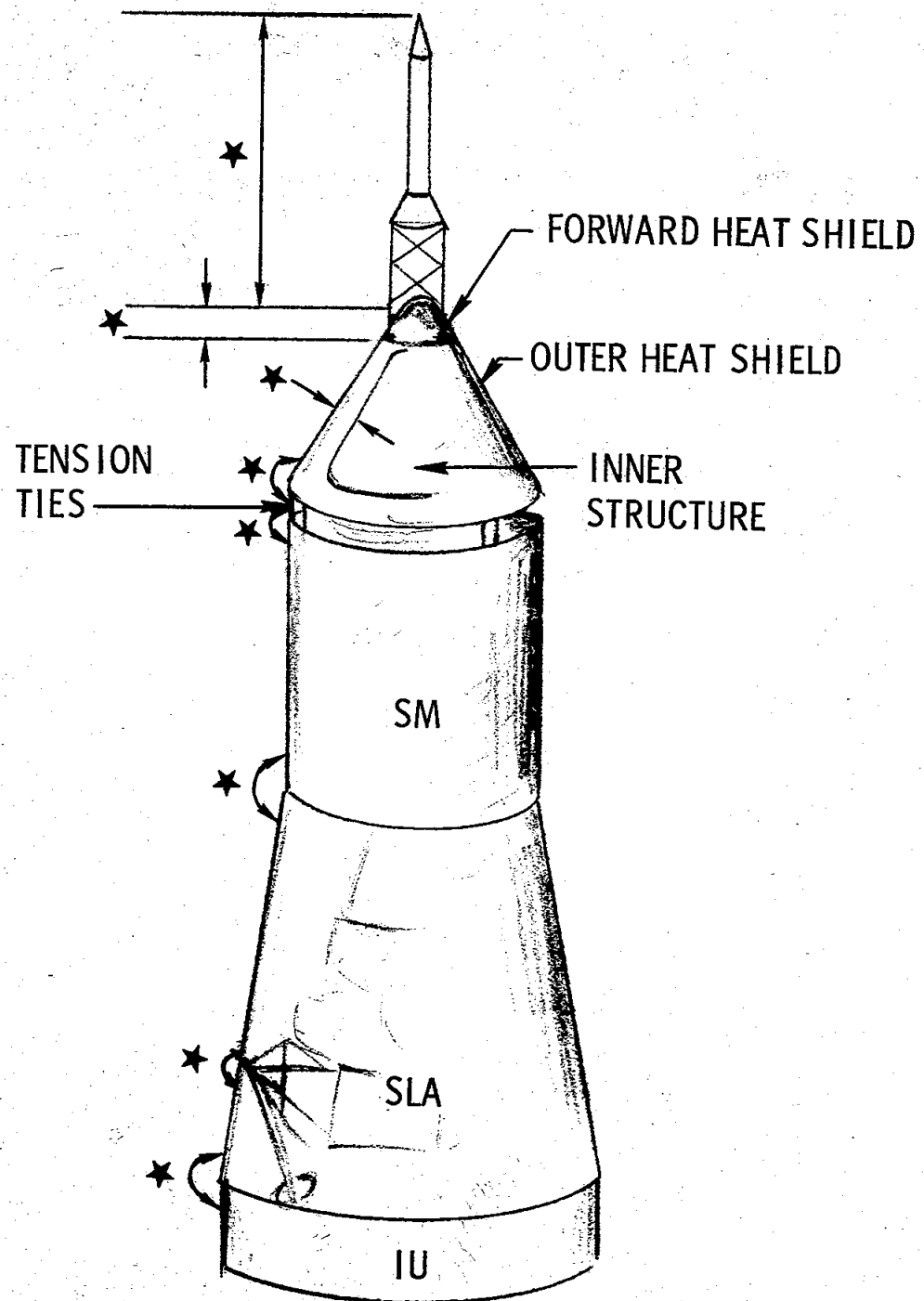
CDU READOUT CAUSED CMC GIMBAL ANGLE OUTPUT TO CONTINUALLY CHANGE
SINCE "SWITCH 3" WAS CLOSED, THUS CIRCUIT LOOP THROUGH 1 AND 2
COULD NOT NULL, THEREFORE PLATFORM TUMBLED

MIDDLE GIMBAL READOUT JUMPED WHEN BIT CHANGED IN COUNTER REGISTER
DUE TO POTENTIAL DIFFERENCE BETWEEN SIGNAL GROUND AND CHASSIS
(INNER AND OUTER CDU READOUTS JUMPED AT 36.5 SEC; HOWEVER, ONLY
MIDDLE GIMBAL HAS GIMBAL LOCK AND TRANSFER FUNCTION TO COURSE ALIGN

- GROUND TESTS VERIFIED MODE OF PLATFORM TUMBLE

STRUCTURE BONDS
(DESIGNED FOR
POTENTIAL DISCHARGE)

★ MEASURED BONDED POINTS



CONCLUSION

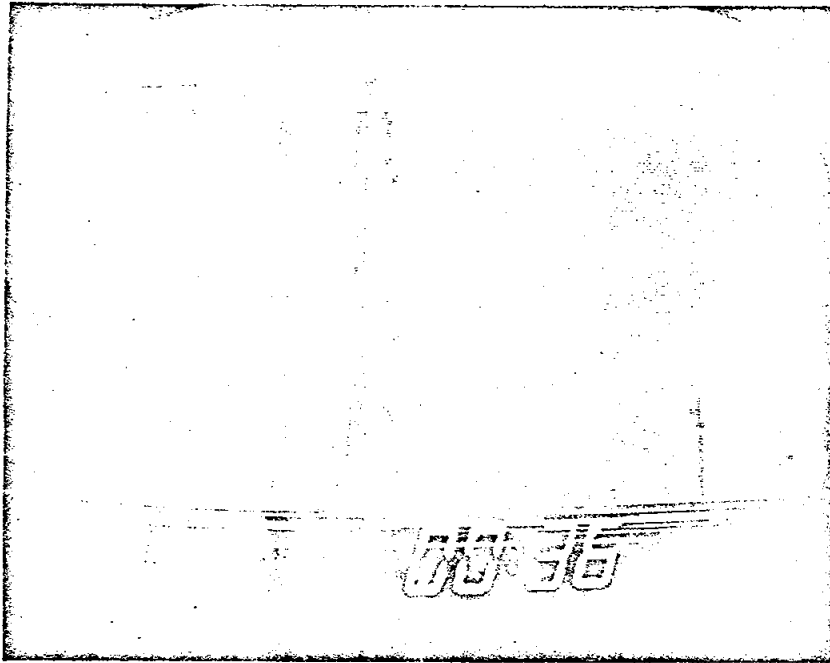
- THE CAUSE OF THE 36.5 AND 52 SEC EVENTS WAS A POTENTIAL DISCHARGE OF THE CLOUDS THROUGH THE SPACE VEHICLE
- STRUCTURAL BONDING OF THE SPACE VEHICLE HAS BEEN DESIGNED AND IS ADEQUATE FOR POTENTIAL DISCHARGES
- THE SYSTEMS THAT WERE AFFECTED HAD PREVIOUSLY EXHIBITED A SENSITIVITY TO TRANSIENT VOLTAGE CONDITIONS DURING GROUND TESTING

PRELIMINARY FINDINGS
OF THE
LIGHTNING INCIDENT
DURING THE APOLLO 12 LAUNCH

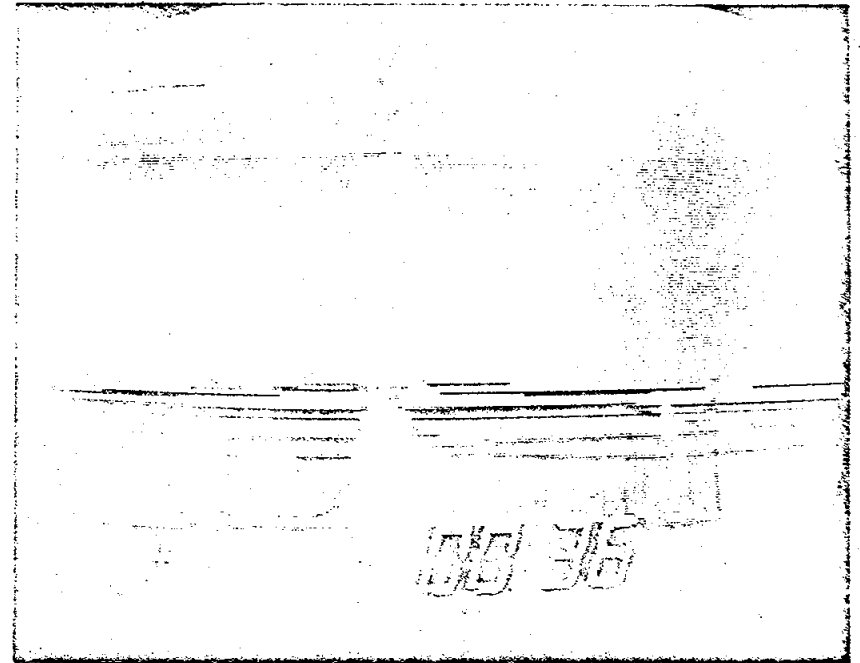
SEQUENCE PHOTOS COVER PAGE

**APOLLO 12 LAUNCH, NOVEMBER 14, 1969
LIGHTNING, PAD A VICINITY**

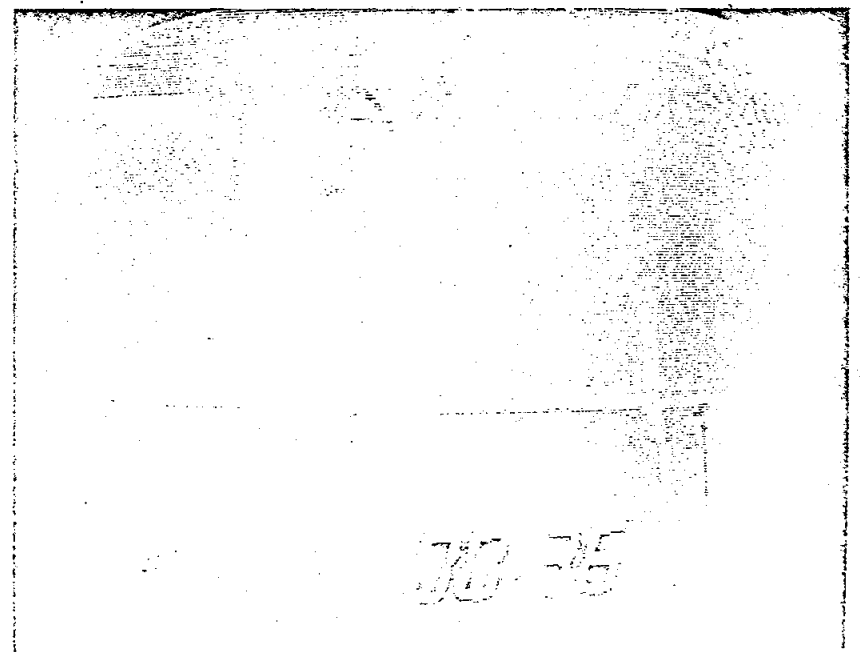
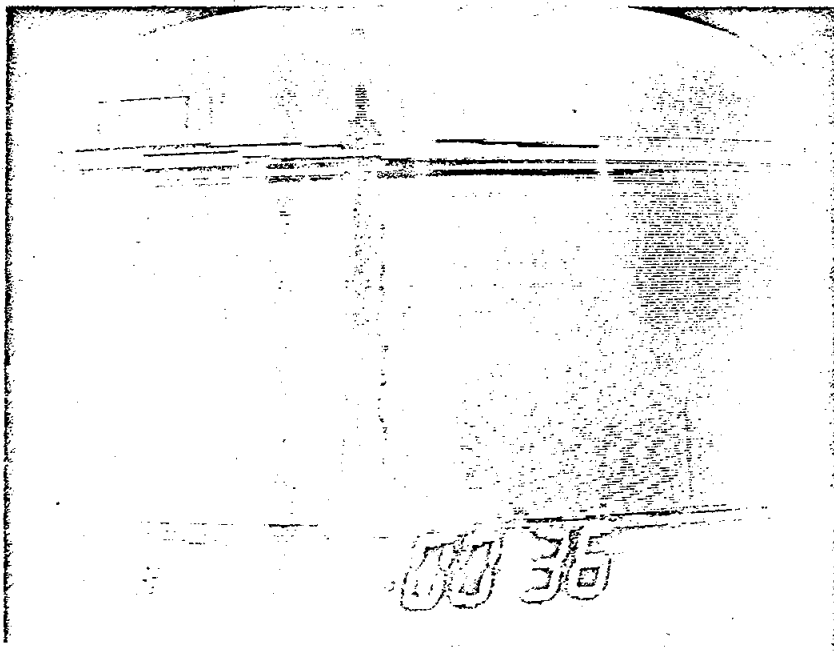
- **CAMERA LOOKING APPROXIMATELY DUE EAST FROM CAMERA SITE 5 (PERIMETER) - ABORT ADVISORY CAMERA NO. 4**
- **INDIVIDUAL EXPOSURES 1/30 SEC, SEPARATED BY 0.001 SECOND BETWEEN EXPOSURES. EXPOSURES ARE SEQUENTIAL, AS TAKEN ON VIDEO TAPE - 11:32:36 AM EST**

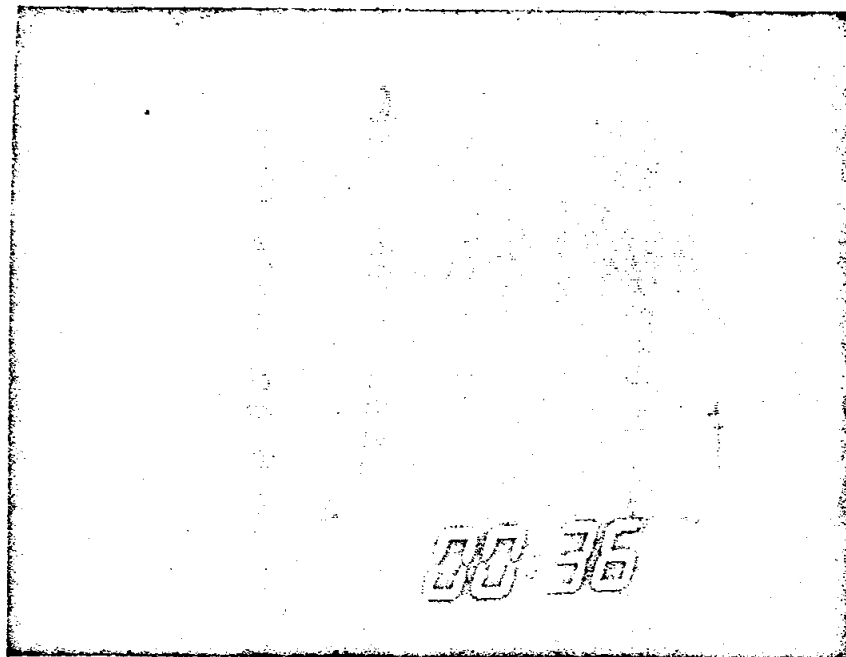


1

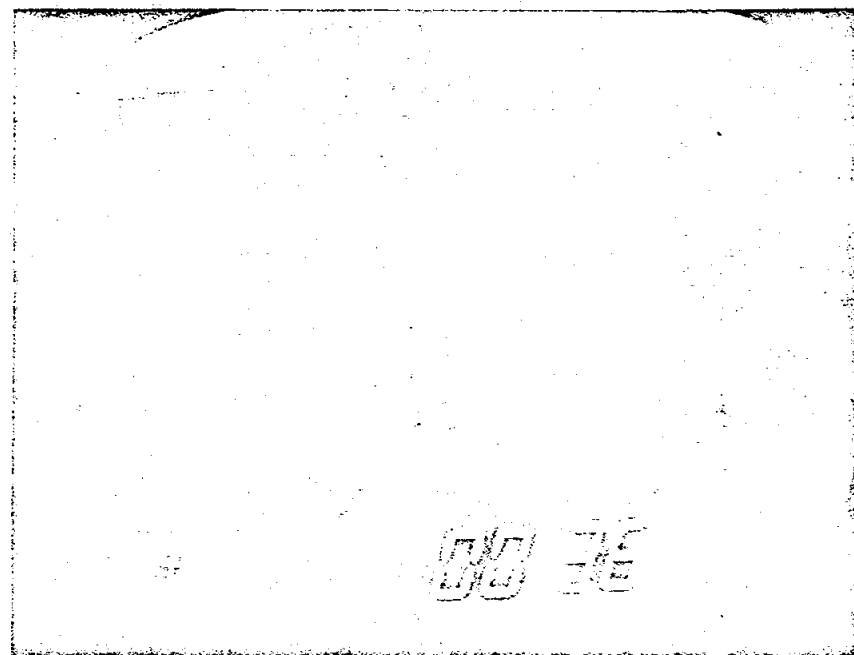


3

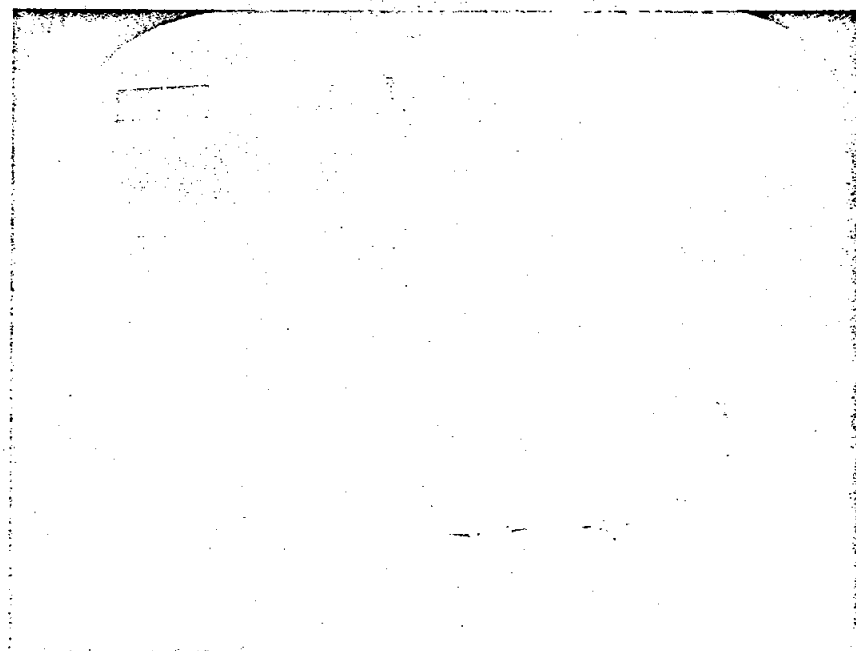
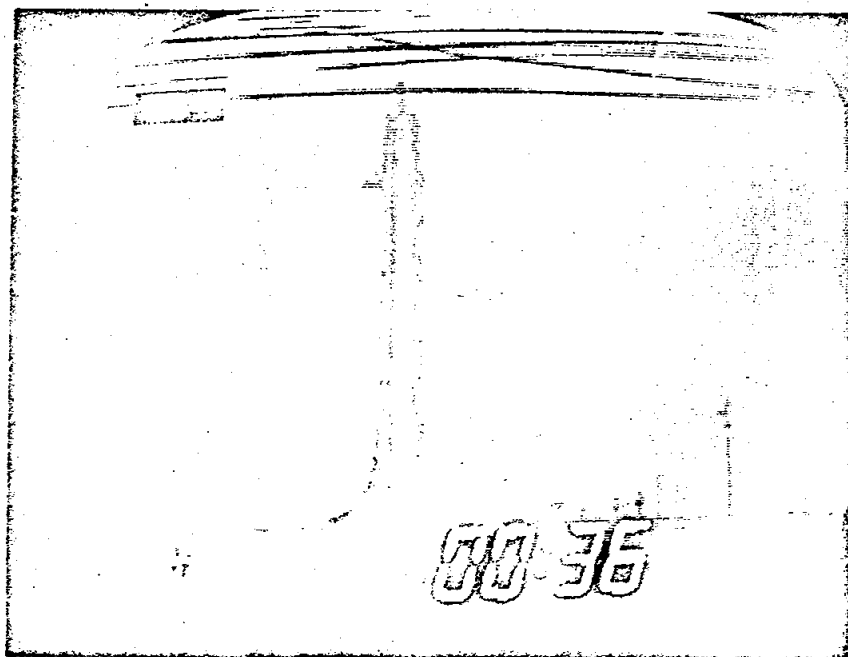




5



7



WEATHER OBSERVATIONS

- NO THUNDERSTORMS IN THE AREA
 - RADAR OBSERVATION
 - POTENTIAL GRADIENT RECORDINGS
 - CLOUD FORMATIONS
- CLOUDS ESTIMATE
 - 800 FEET - BROKEN
 - 10,000 FEET - OVERCAST
 - TOPS ABOUT 21,000
- VISIBILITY 7 MILES
- LIGHT RAIN SHOWERS
- TEMP 70° F, DEWPOINT 66° F
- PRESSURE 29.69 INCHES

OBSERVED CONDITIONS ~ 36

~36 SEC

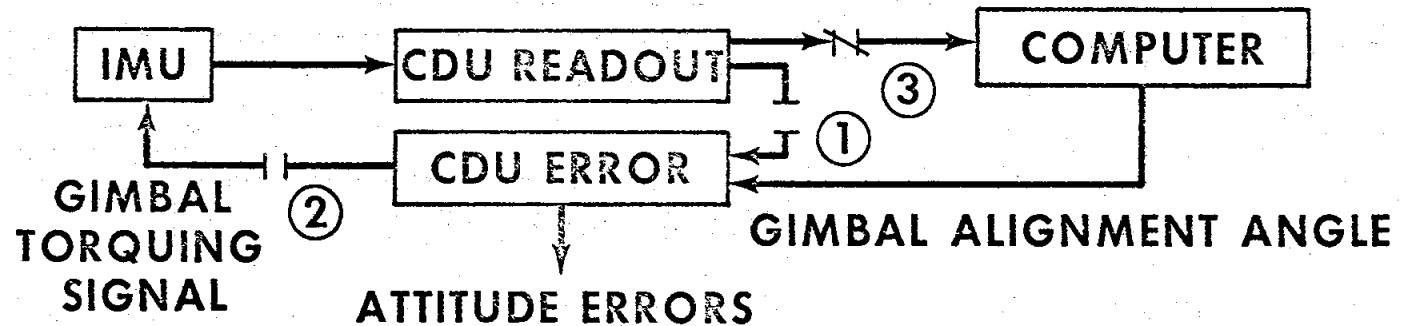
- LIGHTNING STRIKE BETWEEN CLOUD BASE AND GROUND
- CREW SAW BRIGHT LIGHT

36.5 SEC

- FUEL CELLS DISCONNECTED FROM BUS
- NUMEROUS ALARMS AND WARNING LIGHTS IN CABIN
- SIGNAL CONDITIONING EQUIPMENT DROPPED OUT
(90 SEC RETURNED)
- 4 TEMP MEASUREMENTS OUT
- 4 PROPELLANT QUANTITY GAGING MEASUREMENTS OUT
- 1 TEMP MEASUREMENT OF THE NUCLEAR PARTICLE
DETECTION OUT
- IU, S-IVB, AND S-II TRANSIENTS ON SEVERAL MEASUREMENTS

52-SECOND IMU TUMBLE

SIMPLIFIED FUNCTIONAL DIAGRAM



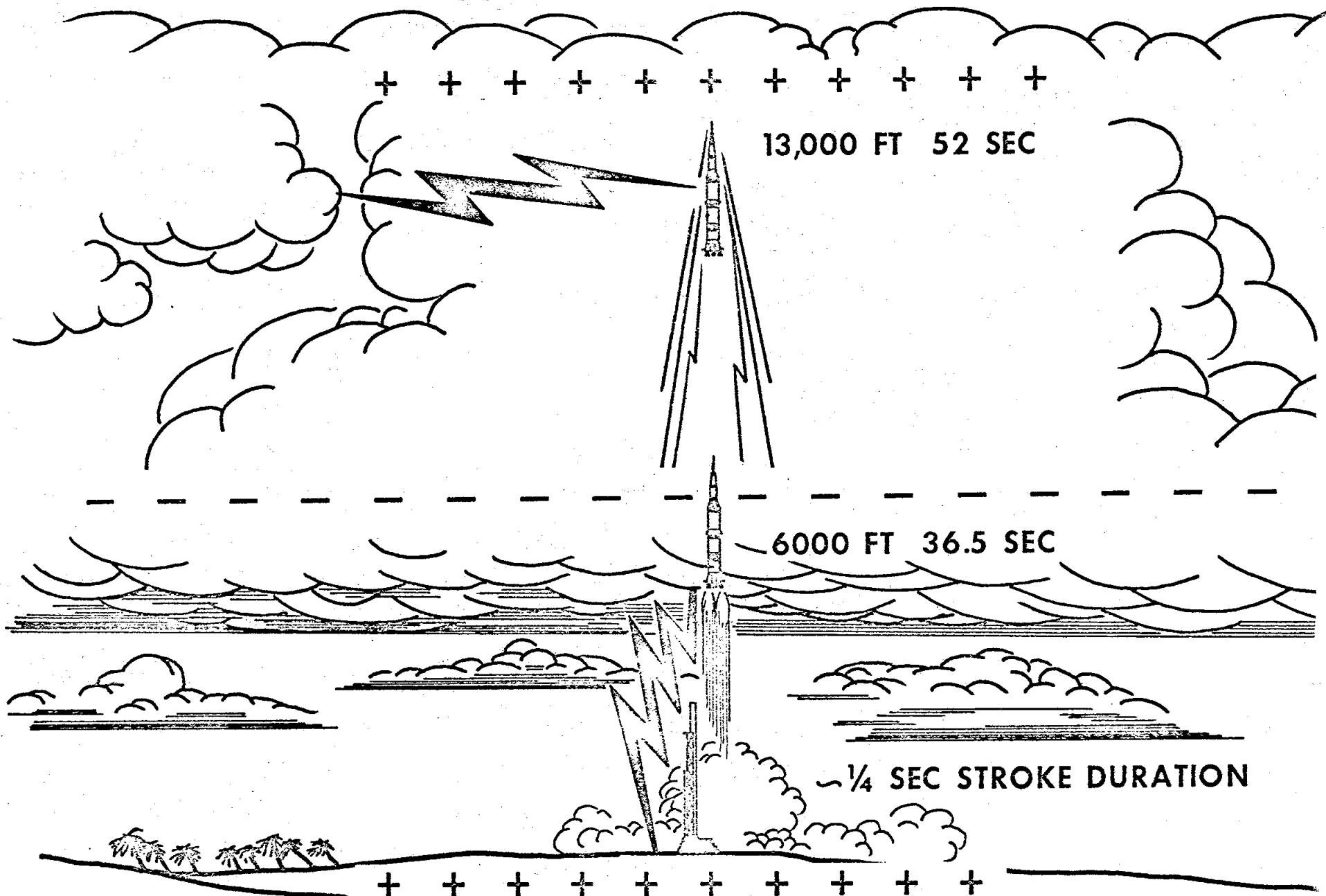
- CDU READOUT OF MIDDLE GIMBAL JUMPED TO OVER 85°
 - 85° READOUT CAUSED CMC TO CLOSE SWITCHES 1 AND 2 (GO TO COURSE ALIGN) (NORMALLY IN COURSE ALIGN 'SWITCH 3' OPEN)
- CDU READOUT CAUSED CMC GIMBAL ANGLE OUTPUT TO CONTINUALLY CHANGE SINCE 'SWITCH 3' WAS CLOSED, THUS CIRCUIT LOOP THROUGH 1 AND 2 COULD NOT NULL, THEREFORE PLATFORM TUMBLED
- MIDDLE GIMBAL READOUT JUMPED WHEN BIT CHANGED IN COUNTER REGISTER DUE TO POTENTIAL DIFFERENCE BETWEEN SIGNAL GROUND AND CHASSIS (INNER AND OUTER CDU READOUTS JUMPED AT 36.5 SEC; HOWEVER, ONLY MIDDLE GIMBAL HAS GIMBAL LOCK AND TRANSFER FUNCTION TO COURSE ALIGN
- GROUND TESTS VERIFIED MODE OF PLATFORM TUMBLE

OBSERVED CONDITIONS (CONT)

52 SEC

- 4 MESSAGE ACCEPTANCE PULSES
- CENTRAL TIMING EQUIPMENT RESET TWICE -
AND CHANGED PULSE RATE
- INERTIAL MEASUREMENT UNIT TUMBLED
- LAUNCH VEHICLE CURRENT SPIKE (IU)

DISCHARGE EVENTS



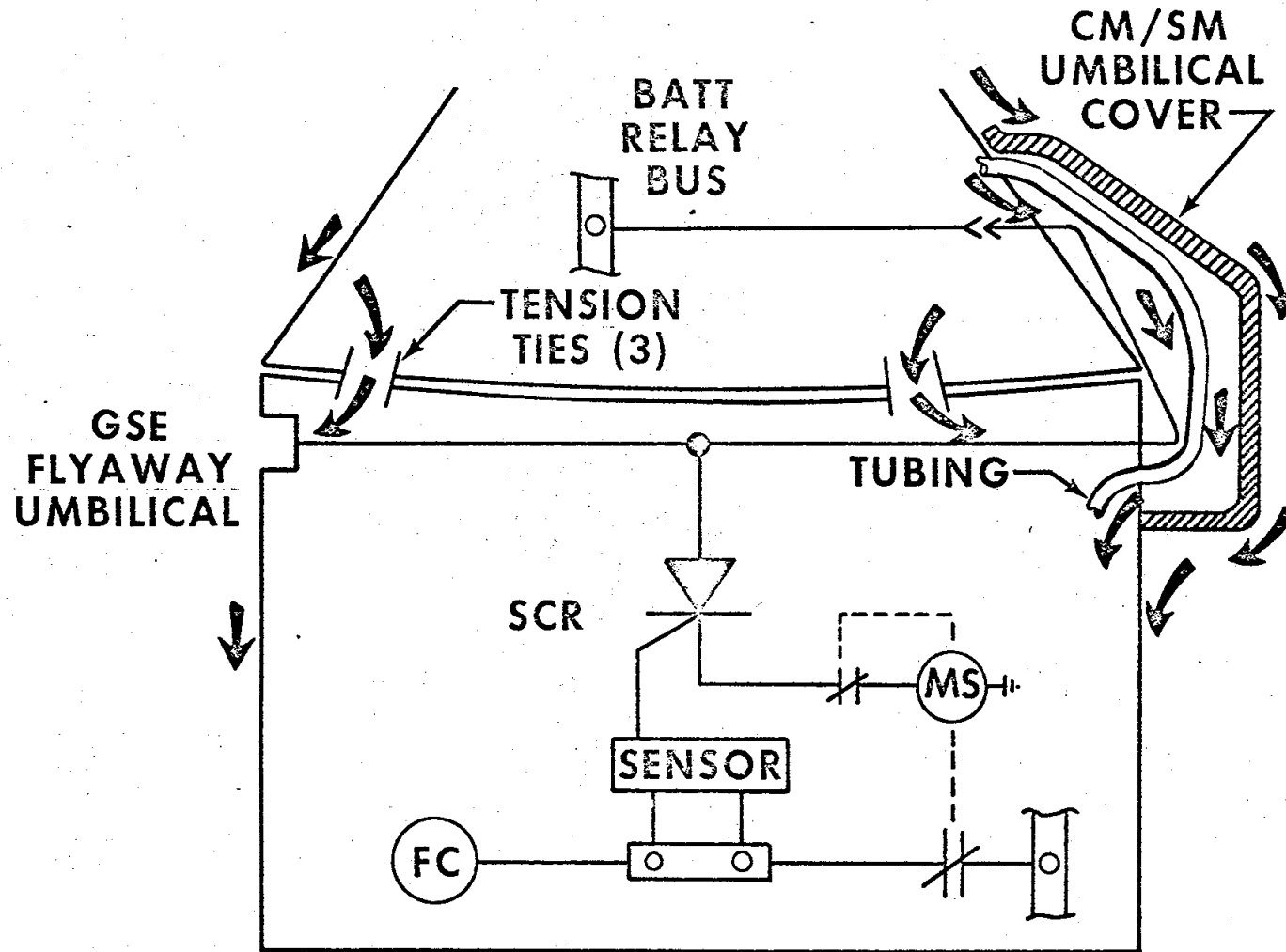
POTENTIAL DISCHARGE EFFECT ON VEHICLE

- INDUCTION INTO WIRING-DEPENDENT ON WIRE LOCATION
AND RATE OF CHANGE OF POTENTIAL
- DIRECT CURRENT FLOW IN GROUNDING

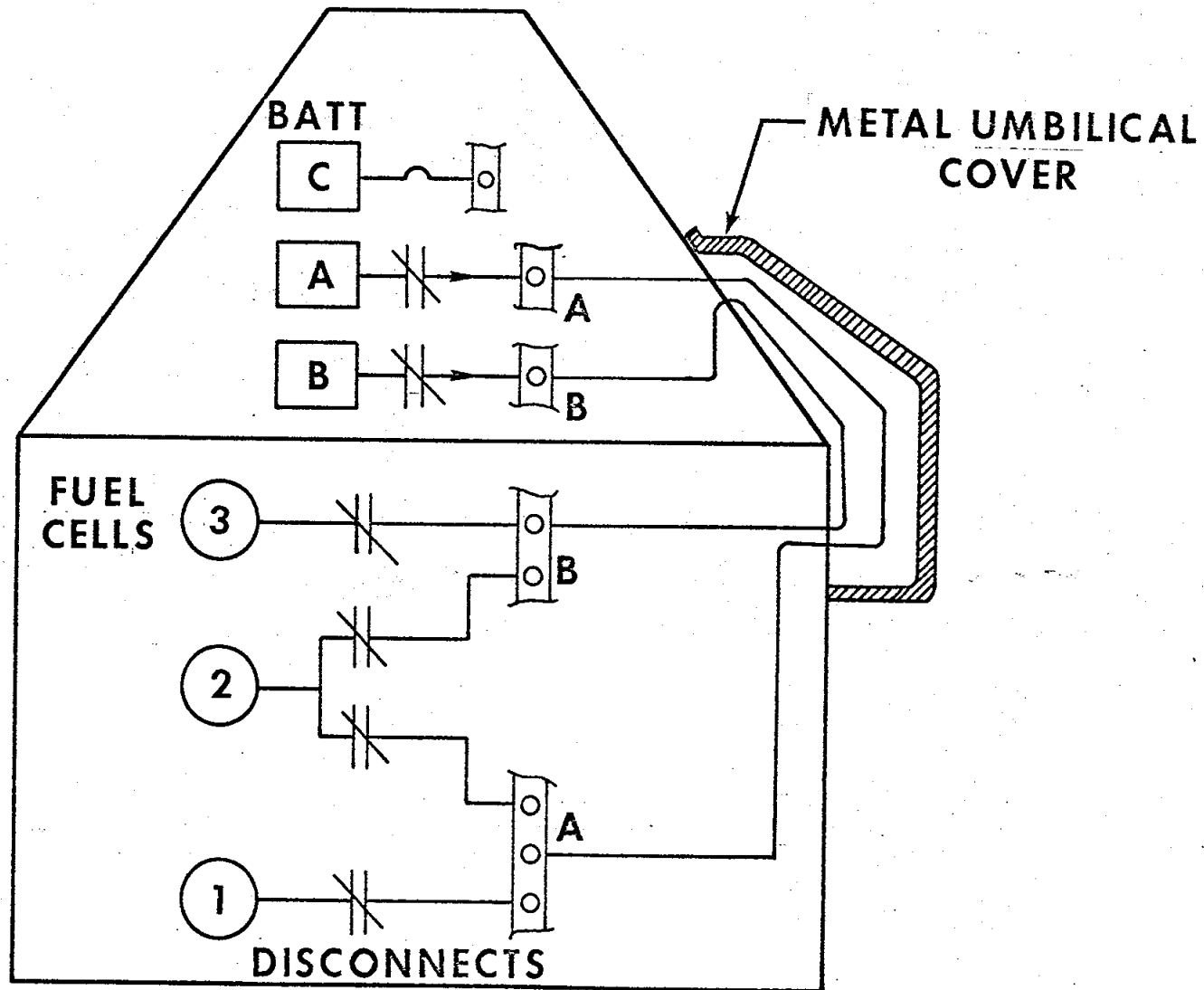
T + 36.5 - SECOND POWER SYSTEM SEQUENCE OF EVENTS

- FUEL CELLS DISCONNECTED (dv/dt) (SEE NEXT DIAGRAM)
 - MAIN BUS A AND B UNDERVOLTAGE (26.25v dc)
 - SCE OFF (22.9v dc)
 - MOMENTARY DROP IN AC VOLTAGE (16v dc)
 - AC BUS 1 AND 2 FAIL (95v ac)
- AC OVERLOAD (dv/dt)

BUS DISCONNECT CIRCUIT AND CURRENT FLOW PATHS

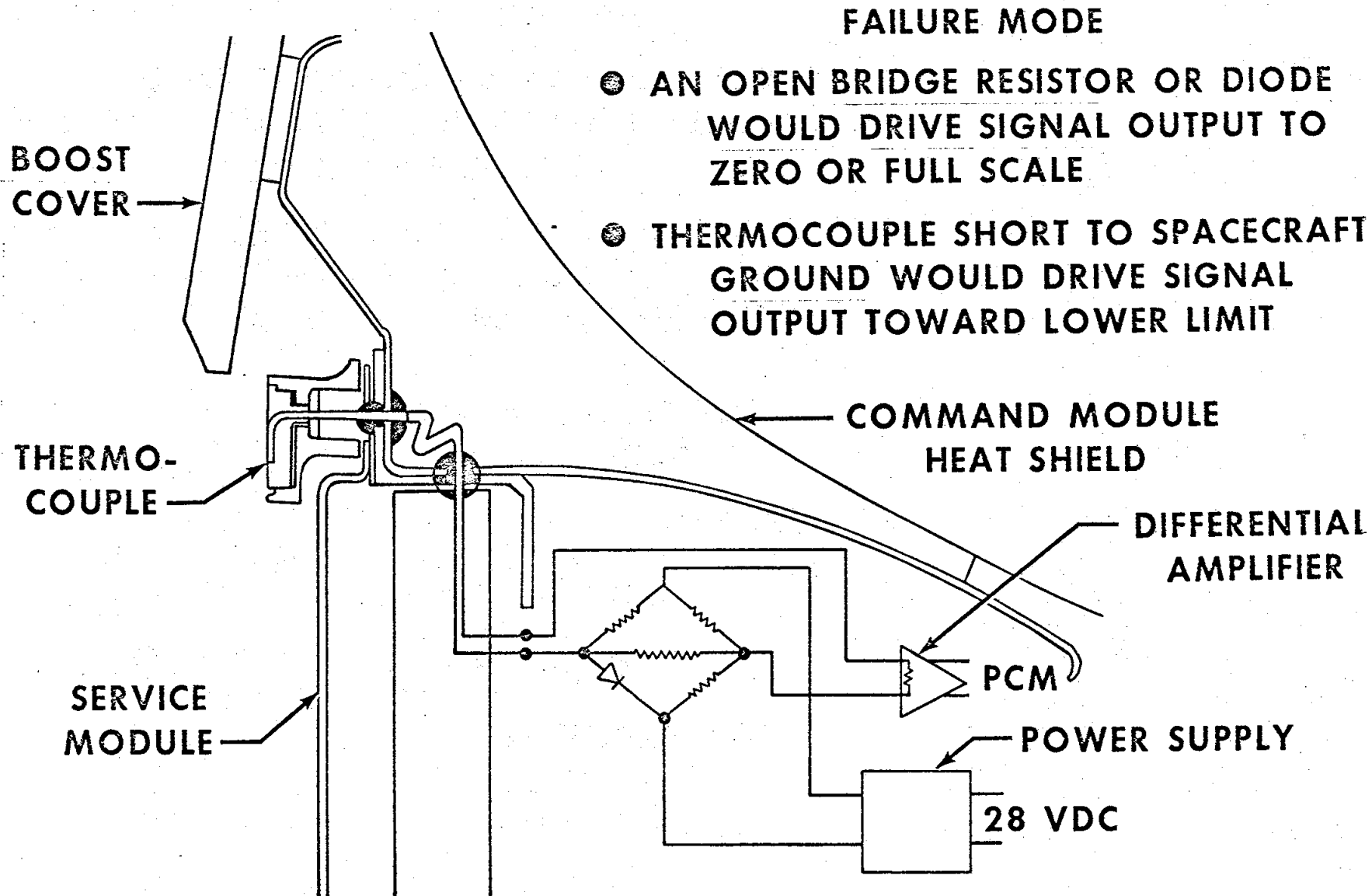


SPACECRAFT DC POWER SYSTEM

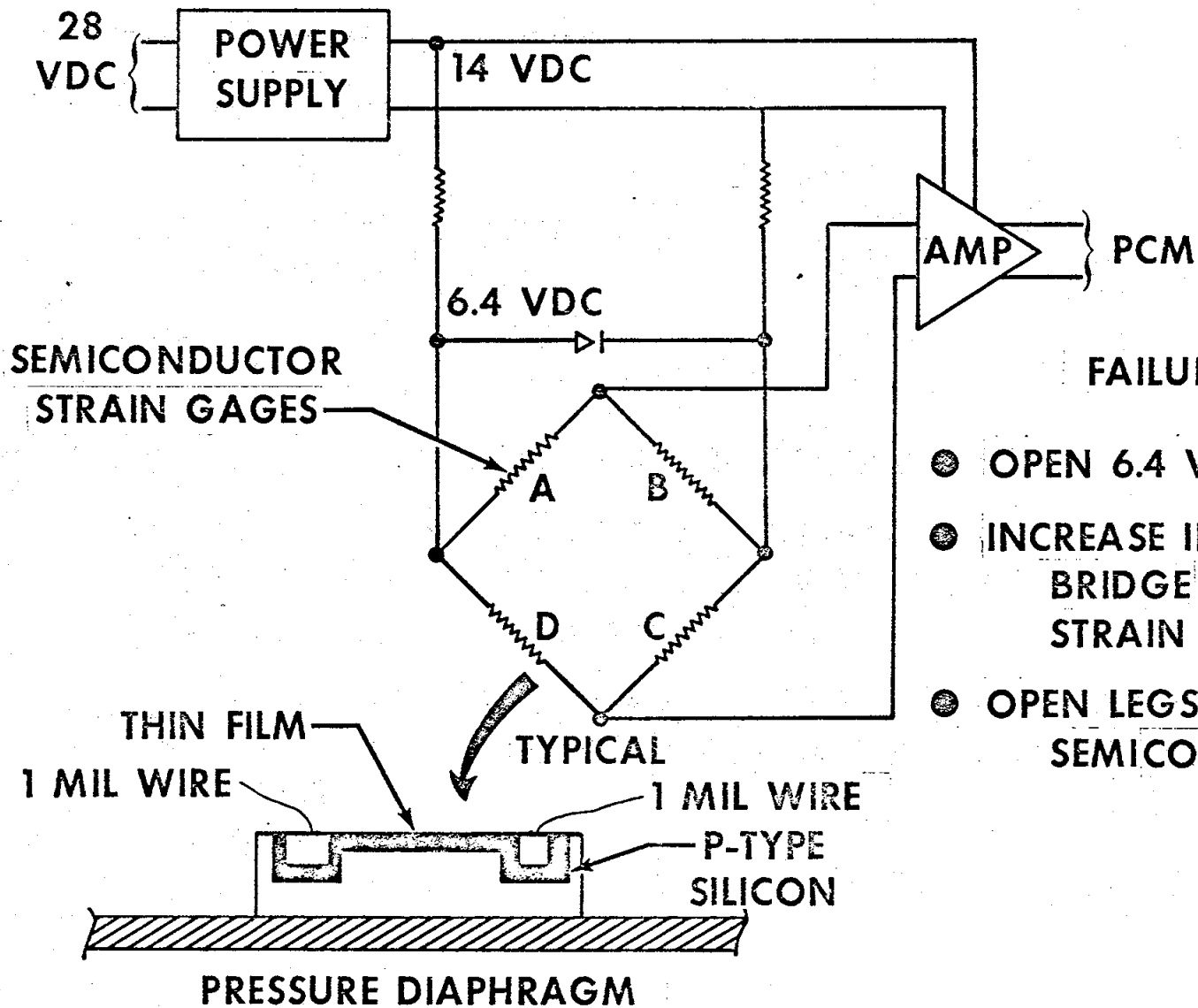


4 THERMOCOUPLES

TYPICAL ONE SHOWN



RES FAILED SENSORS

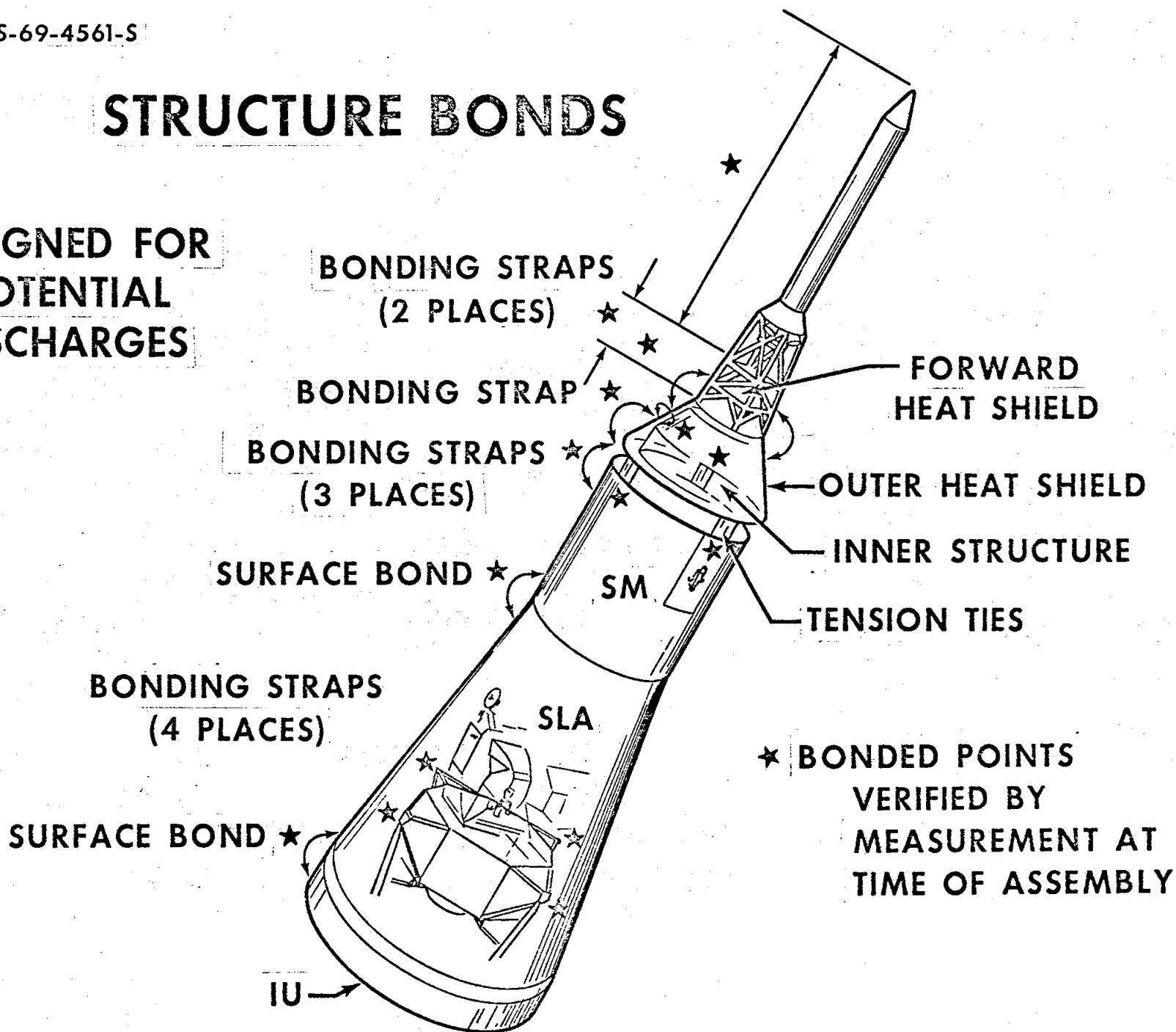


FAILURE MODES

- OPEN 6.4 VDC ZENNER DIODE
- INCREASE IN THIN FILM BRIDGE SEMI CONDUCTOR STRAIN GAGES
- OPEN LEGS (B OR D) OF SEMICONDUCTOR BRIDGE

STRUCTURE BONDS

DESIGNED FOR
POTENTIAL
DISCHARGES



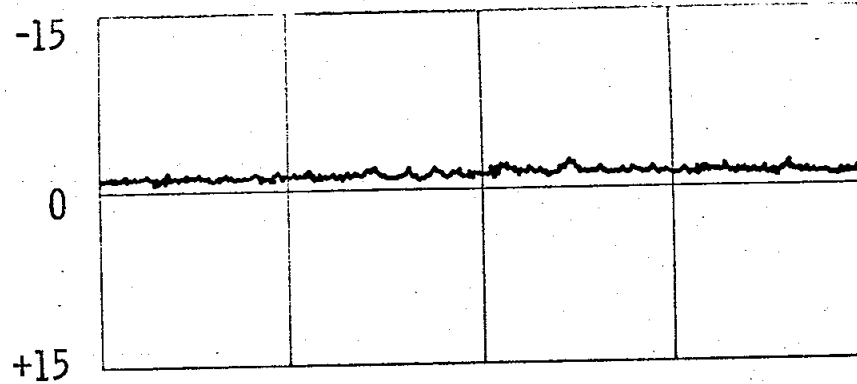
CONCLUSION

- THE CAUSE OF THE 36.5 AND 52-SEC EVENTS WAS A POTENTIAL DISCHARGE OF THE CLOUDS THROUGH THE SPACE VEHICLE
- STRUCTURAL BONDING OF THE SPACE VEHICLE HAS BEEN DESIGNED AND IS ADEQUATE FOR POTENTIAL DISCHARGES
- THE SYSTEMS THAT WERE AFFECTED HAD PREVIOUSLY EXHIBITED A SENSITIVITY TO TRANSIENT VOLTAGE CONDITIONS DURING GROUND TESTING

POTENTIAL
GRADIENT
RECORDINGS

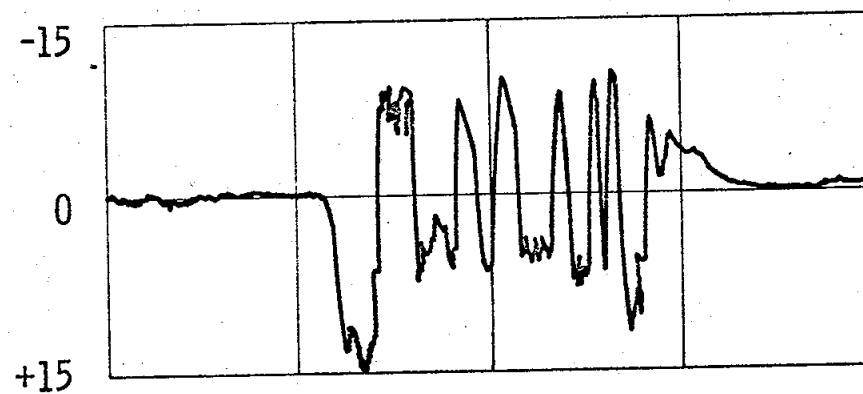
SITE 6

KV/M



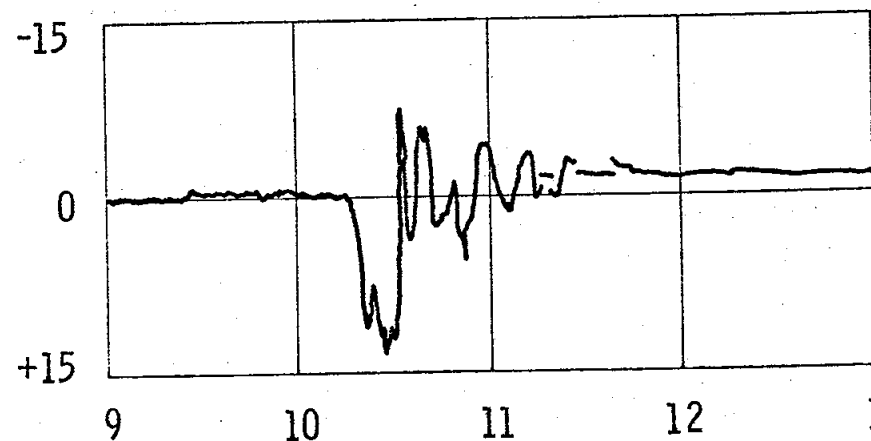
SITE 5

KV/M



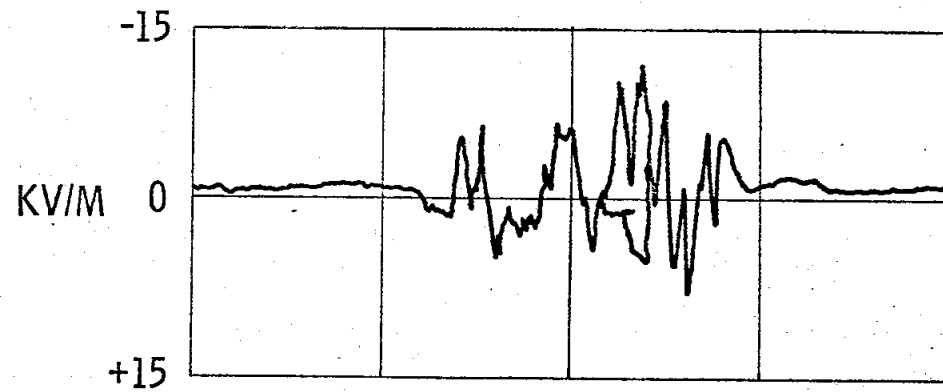
SITE 4

KV/M

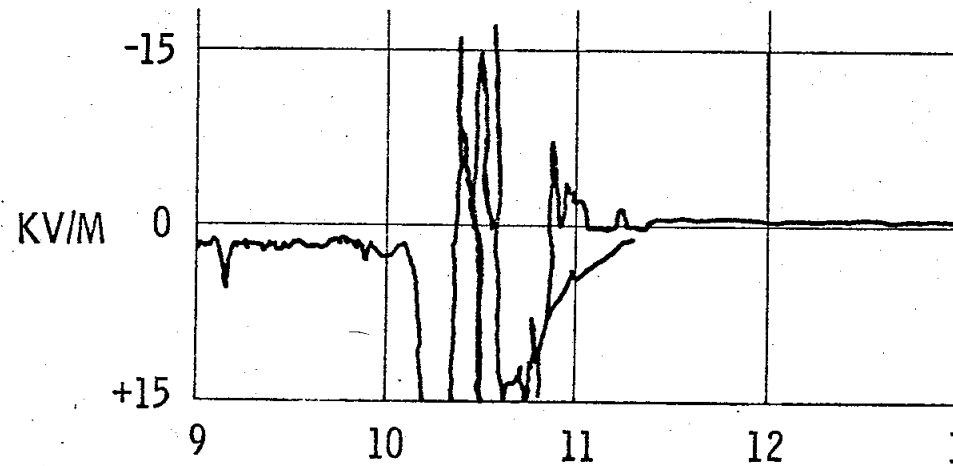


POTENTIAL GRADIENT RECORDINGS

SITE 8



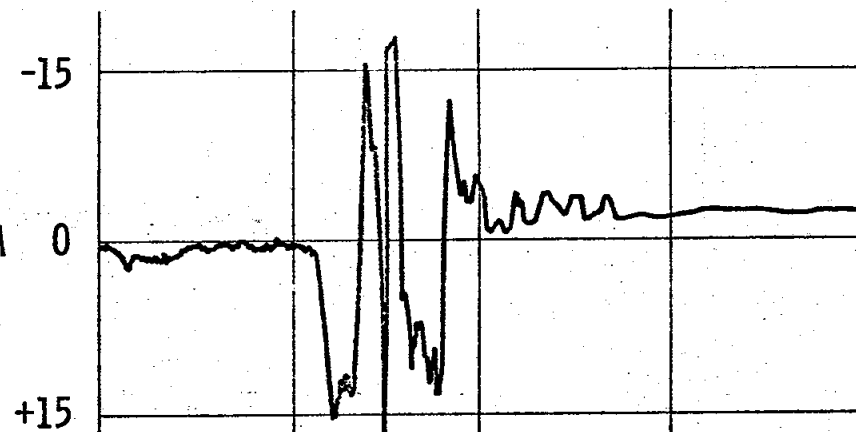
SITE 7



POTENTIAL
GRADIENT
RECORDINGS

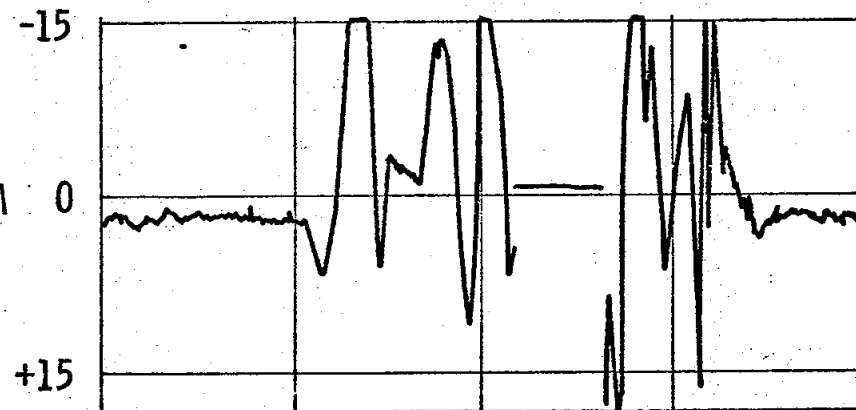
SITE 1

KV/M



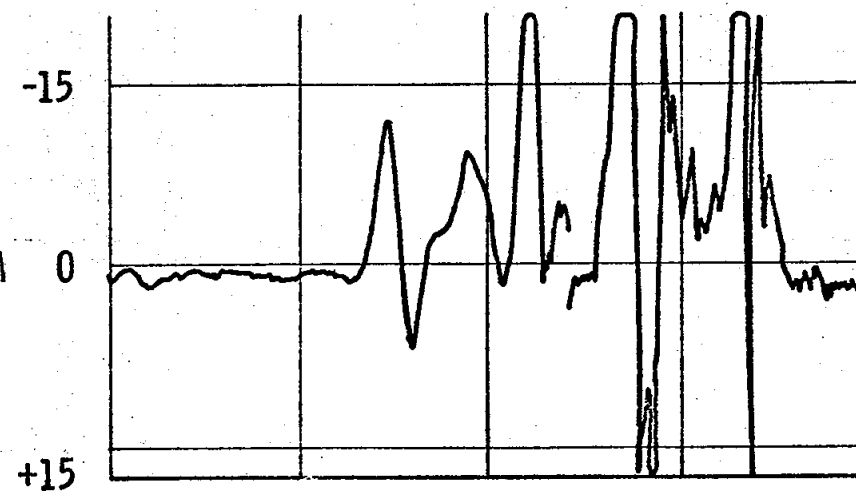
SITE 2

KV/M



SITE 3

KV/M



9

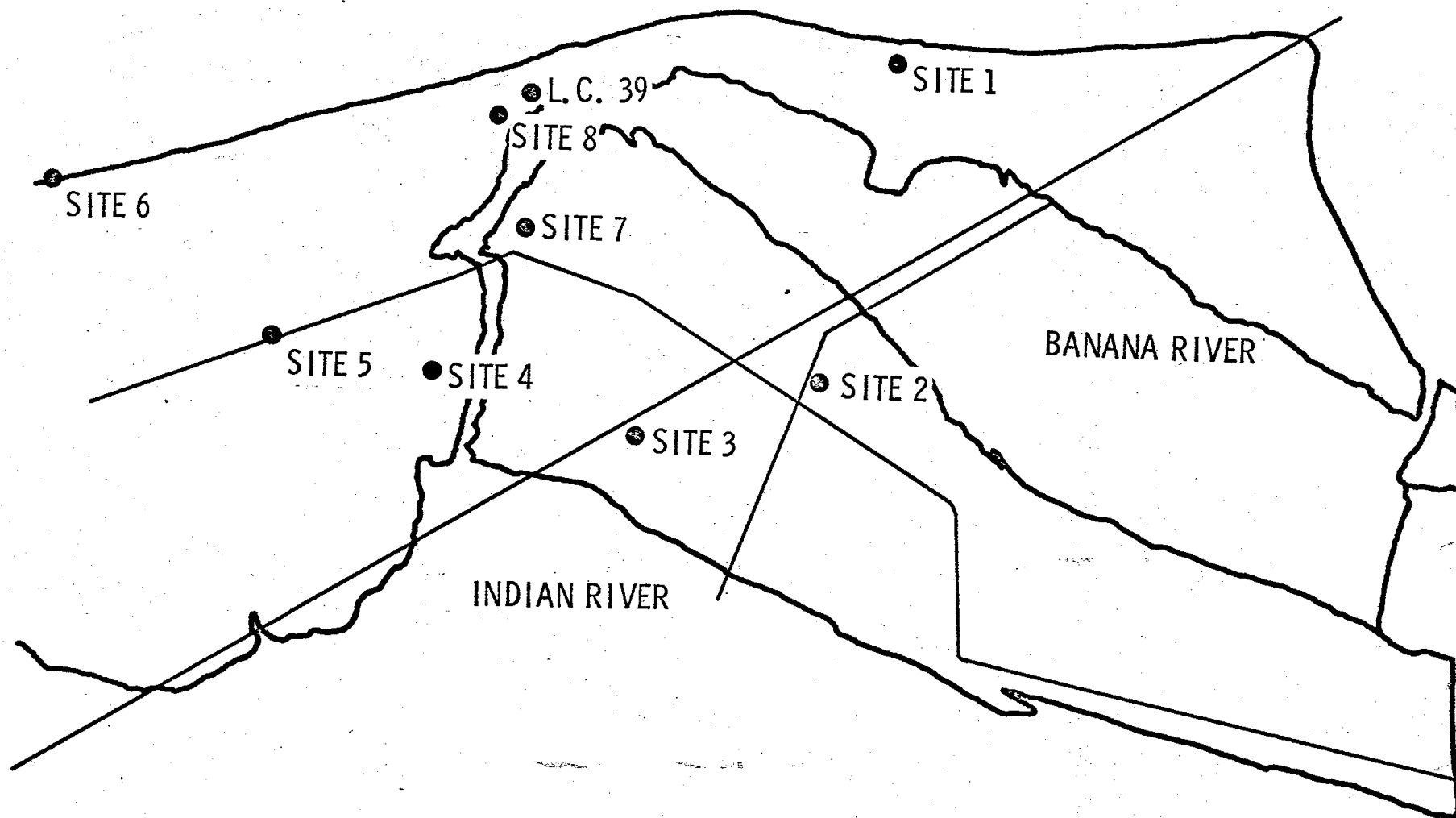
10

11

12

1

POTENTIAL GRADIENT RECORDING SITES



APPROX 6 MILES

BDS 25

Apollo 12 Electrical Anomaly

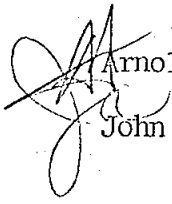
At 36.5 seconds after liftoff a major electrical anomaly occurred in the CSM. This anomaly disconnected all three fuel cells from the main buses, placing main bus A loads on entry battery A and main bus B loads on entry battery B. The crew was alerted by the fuel cell disconnect flags. At this time, total spacecraft current was approximately 75 amps and this load was sufficient to momentarily drop battery and, therefore, main bus voltages, causing an undervoltage glitch on the AC buses for a brief period and turning on AC caution and warning lights.

With the decrease in main bus power the signal conditioning equipment (SCE) ceased to operate (as it is normally supposed to do when main bus voltages decrease to approximately 22 volts). Also, the ground simultaneously lost telemetry lock.

The main bus voltages recovered almost immediately returning to approximately 25.5 volts as evidenced by logic bus readouts from the DSE, neither of which are effected by SCE loss. The SCE controls most other electrical power measurements pertinent to this condition, hence, not much more information is available regarding further characteristics of the anomaly.

At a ground elapsed time of 60.5 seconds PCM lock was reacquired, however, all SCE conditioned parameters were still invalid and the CTE time had experienced a large time shift. At that ~~time~~ the crew was asked to go to the AUX position on the SCE power switch. At 97.5 seconds GET the crew either performed this switching or the main bus voltage rose to a high enough level to cause the SCE to start functioning again while still in

the norm position. Electrical telemetry readouts immediately returned and the crew was asked to restore fuel cell power to the main buses. Fuel cells 1 and 2 were placed on line at 142.5 seconds GET and fuel cell 3 was placed on line at 170.5 seconds GET. Main bus voltages rose to approximately 30 volts and all electrical parameters returned to normal readings. The EPS system has functioned normally since that time.



Arnold D. Aldrich

John Aaron

Preliminary

POWER DISTRIBUTION AND SEQUENCING - R. Munford

T +36 seconds

1. There was a simultaneous loss of fuel cell power to the main buses.
2. There was also a loss of AC voltage. ².
3. There was a loss of PCM for about 14 seconds.
4. EPS measurements were lost for about 58 seconds.
5. The crew later reported a bright light at this time, assumed it was lightning.
6. The ground (KSC Weather) reported later there was a lightning strike at this time.
7. The booster people reported later that they had a platform glitch at this time.

T +1:34

1. When EPS data returned all loads were carried by batteries A and B.
2. Main buses were ≈ 24 VDC.
3. About 40 amps were being drawn from each battery (normal for the situation).

T +2:20

Fuel cells were put back on the buses successfully.

CONCLUSIONS

1. Lightning glitched the fuel cell motor switch sensors causing them to turn off. (Similar to glitch caused by RCS quad simulators on early vehicles during the MSOB altitude tests.)
2. As a result DC voltage dropped below inverter sustaining voltage of about 16 volts. Therefore, AC power was lost.
3. After about 14 seconds battery voltage rose above the inverter cutoff voltage because PCM was restored.

4. Since EPS measurements go via SCE they did not return until about 58 seconds later because either SCE switch was turned to auxilliary ✓ or voltage rose to turn on value of about 23 or 24 volts.
5. Systems have all operated properly ever since fuel cell power restored. ✓
6. Crew reported the following C&W lights on:

Main Bus A Undervoltage

Main Bus B Undervoltage

AC Bus 1 Fail

AC Bus 2 Fail

AC Bus 1 Overload

AC Bus 2 Overload

Fuel Cell #1 Disconnect

Fuel Cell #2 Disconnect

Fuel Cell #3 Disconnect

Apollo 12 Electrical Incident

At 36.5 seconds after liftoff, a potential discharge was believed to have occurred with the spacevehicle and caused a sequence of events to happen in the spacecraft. The fuel cell overload sensors disconnected each of the fuel cells from the power buses. These sensors have lines which go to an exterior umbilical on the spacecraft and are used during ground checkout. The potential discharge was probably sensed on these lines and falsely interpreted as an overload condition and removed the three fuel cells from the main buses. Consequently, two of the three batteries which were connected to the main bus would have been instantaneously subjected to the normal spacecraft load. The battery voltages would have dropped momentarily and recovered. During this low voltage period, the spacecraft inverters sensed the low battery voltage and stopped supplying AC until the DC voltage was sufficiently high to operate the inverter again. The loss of AC caused the telemetry system to be lost. The battery voltage recovered to a sufficient level in about 60 seconds into the flight to allow normal operation of all systems. The crew returned the fuel cells to the buses in about 3 minutes.

Other affects were the loss of alignment of the inertial platform which was later realigned. Eight instrumentation measurements were lost at the instant of the potential discharge and were not recovered. These were 4 temperature sensors on the SM skin and 4 pressure-temperature sensors which function as a secondary system to supply the SM RCS propellant quantity measurement.

As a result of the event, all appropriate systems were verified in the command module prior to TLI and an early entry into the LM was made to assess those systems.

There were some alterations made to the mission. There are no other known affects of the potential discharge.

QUERY: SH 

Date

Time

SOURCE OF QUERY (Name and Affiliation):

Richard Witkin, NY Times

212 556 1087 #62

Received by

Mission Evaluation Room

Time and date answered

4:10 PM 11-15-69

Query:

Dick Witkin requests information on present plans, possible changes, modification, status, etc. on the Apollo electrical system as result of transients noted in CSM at approx 36 seconds GET, 14 Nov.

Quoting witkin, "May I have a post mortem on the electrical problem?"

nse:

See attached text!

*When given in our next phase base
Done Givens X 511*

EPS Anomaly at GET 36 Seconds

At approximately GET 36 seconds there was a loss of data for approximately 58 seconds. After AOS the data indicated that all 3 fuel cells were supplying zero current while battery A and B were supplying 41 and 36 amps respectively. The main bus A and B voltages were 24.5 volts. The AC bus 1 and 2 voltages were normal at 115.7 and 116.3. The crew reported that they had the following EPS indications:

1. 3 Fuel Cell disconnect.
2. Main Bus A and B undervoltage.
3. AC Bus 1 and 2 fail.
4. AC Bus 1 and 2 overload.

The crew reported indications were consistent with the PCM data. At approximately GET 139 seconds, the crew reconnected the fuel cells to the main buses. All EPS parameters were normal subsequent to the fuel cells being reconnected to the buses.

In reviewing the available data, ~~and the crew reported~~ ^{the} ~~and ground observed~~ ^{reported} lightning strike at the time of the anomaly, it is hypothesized that the lightning current in the CSM structure produced a magnetic field that induced a voltage transient in the Battery Relay Bus (BRB) circuit. The logic voltages for the fuel cell motor switch overcurrent sensor, AC bus voltage sensor, AC inverter overcurrent sensor and ECS radiators motor switch overcurrent sensor are supplied by the BRB. The wiring from the BRB to the F/C motor switch sensor and ECS radiator motor switch sensor are routed in the CM-SM umbilical. In addition, the F/C sensor wires are also routed to the GSE Flyaway connector. It appears reasonable to assume that the hypothesized

induced voltage in the BRB occurred in these wires close to the CSM skin.

The assumed voltage transient in the BRB created the anomalous condition by causing the F/C and inverter overload sensor SCR's to falsely trip by a DV/DT phenomenon. Nuisance trips of the F/C motor switch sensor and inverter overload sensor have occurred on other spacecrafts during ground testing. The F/C sensor trips occurred under non-flight conditions and, therefore, no fixes were proposed. The inverter sensor trip did result in a fix on all Block II spacecrafts that lessened the chance for a nuisance trip in addition deleted the automatic inverter disconnect function in the event of an overload sensor trip.

The ECS radiator motor switches (2 primary and 1 secondary) have sensor circuits similar to the F/C sensor, consequently, these motor switches may have nuisance tripped. The condition of these motor switches will not be known until the primary radiator outlet temperature drops below -15 degrees or secondary outlet of +42 degrees.

The AC bus 1 and 2 fail indication was caused by a trip of the AC bus under-voltage sensor. There are several possible ways that the sensor was caused to trip. The sudden drop in main bus voltage when the F/C's were disconnected from approximately 30 volts to 20 volts (DSE data of the logic bus A and B which ^{are} ~~is~~ not conditioned by the SCE indicated 20.8 and 24.8 volts respectively for approximately 0.3 seconds then recovery to 25.6 volts until the F/C's were reconnected) would momentarily drop the AC voltage, however, the AC

voltage should recover before the AC sensor trips (nominally in 0.030 seconds). It appears at this time that the most probable cause was a turn off of the inverter AC output caused by a momentary drop in main bus voltage to approximately 17 volts. A sensing circuit internal to the inverter automatically turns "off" and "on" the AC output if the DC input drops or increases to a range of 16 to 19 volts.

N. J. Harris 11/15/91

INSTRUMENTATION, DISPLAYS AND CONTROLS, CAUTION AND
WARNING, POWER DISTRIBUTION AND SEQUENCING

Objective: Review equipment not yet used for possibility of damage by
launch anomaly and recommend testing

Items Not Yet Used:

LM Instrumentation:

Data storage equipment assembly (DSEA)
Caution and Warning Equipment Assembly (CWEA)
Landing Gear Deploy Transducers

LM Displays and Controls:

Condition of some items not yet reported by crew, but no reason to
suspect damage.

CSM Displays and Controls:

Condition of some items not yet reported by crew, but no reason
to suspect damage.

CSM Power Distribution:

Inverter No. 3

CSM Sequences:

Service Module Jettison Controller (SMJC)
Earth Landing Sequencing Controller (ELSC)
Pyro Continuity Verification Box (PCVB)
Reaction Control System Controller (RCSC)

CSM Instrumentation:

No items which have not been exercised.

Conclusion:

No reason to suspect damage on unused items.

No recommendations for special testing.

TELECOMMUNICATIONS

OBJECTIVE: Review communication equipment from standpoint of items not yet used, which might have been affected by launch glitch.

CONSIDERATIONS:

ITEMS NOT YET USED: Secondary USB transponder, VHF Recovery Beacon, Digital Ranging Generator, Rendezvous Radar Transponder, Secondary HGA Electronics, certain UDL relays, and redundant PCM and PMP circuitry.

APPARENT GLITCH CONDITIONS: Short duration low voltage or no voltage condition on AC buses and possibly certain DC buses.

DISCUSSION:

1. Much of above circuitry is similar to circuitry and components which were operating at time of glitch. We can assume that since no failure occurred in equipment that was operating, non-operating, but similar equipment and redundant ^{EQUIPMENT} should be OK.
2. Recovery beacon had no power applied with switch in "OFF" position, but cannot be tested.
3. Digital Ranging Generator is in same category as Recovery Beacon -- cannot be tested, but had no power applied.
4. Rendezvous Radar Transponder -- can be "self-tested" which tests receiver portion of unit. It also had no power applied at time of glitch.

RECOMMENDATION: No special tests are recommended.

SOUTHEAST DIVISION - HOUSTON - P.O. BOX 58747 - HOUSTON, TEXAS 77058

November 19, 1969

IN REPLY REFER TO

Revision 1 to:

5-2700-HOU-356

Dated Nov. 18, 1969

James A. McDivitt, Col., USAF
Manager, Apollo Spacecraft Program
National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas 77058

Dear Jim,

Atmospheric electrical disturbances were observed in the vicinity of the Apollo 12 space vehicle during the initial boost phase. Previous missile program experience caused us to be concerned that the spacecraft may have sustained latent damage and we have initiated an immediate investigation to determine possible mechanisms through which detrimental energies could have entered the spacecraft. We have reviewed the LM subsystems to determine the extent to which their respective essential elements have been or will be tested prior to committing the LM to powered descent. (See Attachment A)

Preliminary results of this investigation indicate that all essential LM subsystems that can be checked will be checked prior to powered descent. Our investigation further has not given us reason to doubt the integrity of the ascent propulsion system and explosive devices which cannot be checked prior to use. We do, however, recommend that visual inspections of the CSM and LM exterior surfaces be made after separation to note any damage, particularly to the LM thermal and micrometeoroid shielding, or to the CM/SM umbilical area. Our concern is that small, millimeter size holes may have degraded these surfaces.

We have reviewed the spacecraft lightning protection and bonding design requirements and the vehicle bonding interfaces (see Attachment 1) and find them to be adequate, however, the total discharge energy that the spacecraft must withstand should be stated. In our preliminary review of the space vehicle shield design, we have identified the CM/SM umbilical as a potential entry to allow the generation of transient electromagnetic fields along the umbilical plumbing (oxygen and potable water lines) and the umbilical outer skin. The transient electromagnetic coupling can introduce voltage differences in the unshielded, untwisted wire pairs that provide CM battery relay buss power to the fuel cell motor switches.

Col. McDivitt

-2-

5-2700-HOU-356

Actual application of motor switch power is controlled by a Silicone Controlled Rectifier (SCR) which is known to be sensitive to transient voltage. Because of this sensitivity, arc suppression diodes were installed across RCS engine valves and other coil operated valves and relays for the specific purpose of reducing voltage transients seen by this SCR. It is expected that the high amperage current flowing through the plumbing in the CM/SM umbilical and the umbilical shield caused sufficient EMI to be coupled into the battery relay buss power lines to trigger these SCRs. This mechanism for the fuel cell disconnect is shown in Attachment 2. The events which occurred subsequent to the atmospheric electrical discharge are explainable by the sudden removal of the fuel cells from the SM DC busses, sudden shifting of the electrical load to the batteries causing low DC buss voltage transients, followed by computer disconnect, due to its low voltage protection, and activation of Caution and Warning lights.

Our immediate concern following the anomaly was for the potential effect on pyrotechnic circuits or devices. We contacted Dr. James Axtell, Boeing-Seattle, and Dr. Joe Manevich - Stanford Institute of Research, (both of whom worked with Boeing in changes to the Minuteman system for the electromagnetic pulse protection), and Dow Martin who has worked with us previously on Apollo ordnance. The Apollo pyrotechnic device wiring is shielded twisted pairs isolated from other spacecraft wiring, and the circuits are shunted or grounded until use. The SBASIs include a spark gap to provide capability for a 25,000 volt electrostatic discharge survival. Based on this information and test experience with other hot wire ordnance initiating devices we concluded that the devices with longest electrical leads would be most susceptible to electromagnetic pulses and the most likely failure mode would be to "fire", not to become "unfireable". Since all pyrotechnic functions to date have operated successfully (including those with the longest leads) and there is no evidence of unplanned operation we consider that failure of the pyrotechnic system represents a low risk.

Our review of the planned checkout of the remaining LM systems shows these checkout plans to be adequate for identifying malfunctions that could have been caused by this anomaly. The ascent propulsion system cannot be checked prior to its actual use. However, before commitment to powered descent all other propulsion systems on both modules will have been successfully fired. This, coupled with the fact that we have not been able to identify a path for significant electromagnetic coupling into the LM, leads us to conclude the APS will perform properly when called upon.

Col. McDivitt

-3-

5-2700-HOU-356

We intend to pursue the analysis of this discrepancy to gain deeper understanding of the cause and potential effects on spacecraft equipment. Attachment 3 is an outline of this analysis.

We will provide D. Arabian with this report and with immediate access to any data or results from our review.

Sincerely,


H. D. Boring, Deputy Manager
Southeast Division - Houston

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIESDATE: NOV. 18 1969BY: W. J. WAUGHSUMMARYSUBSYSTEMADDITIONAL TESTS

o STRUCTURES	o INSPECT THERMAL INSULATION AND MICROMETEOROID SHIELDING DURING STATION KEEPING
o CSM ELECTRICAL POWER & SEQUENTIAL EVENTS CONTROL	o VISUAL CHECK OF CSM FOR LIGHTNING DAMAGE BY LM FOLLOWING CSM/LM SEPARATION, IF FLIGHT CONSTRAINTS PERMIT.
o LM REACTION CONTROL	o NONE
o DESCENT PROPULSION SYSTEM	o NONE
o ASCENT PROPULSION SYSTEM	o NONE
o ENVIRONMENTAL CONTROL SYSTEM	o NONE
o EXPLOSIVE DEVICES	o NONE
o BATTERIES	o NONE
o LM ELECTRICAL POWER DISTRIBUTION	o NONE
o LM COMMUNICATIONS	o NONE
o CSM COMMUNICATIONS	o NONE
o LM RADAR	o NONE
o LM INSTRUMENTATION	o NONE
o LM GUIDANCE & CONTROL	o NONE
o LM DISPLAYS & CONTROLS	o NONE

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: C.T.GOLDEN

o SUBSYSTEM - STRUCTURES

o ESSENTIAL ELEMENTS

- o LANDING GEAR
- o LM EXTERNAL THERMAL INSULATION
AND MICROMETEOROID SHIELDING
- o DROGUE MATING SURFACE

o ADDITIONAL TESTS

- o INSPECT THERMAL INSULATION AND MICRO-
METEOROID SHIELDING DURING STATION
KEEPING
- o INSPECT DROGUE MATING SURFACE
FOR STRUCTURAL DAMAGE RESULTING
FROM HARD IMPACT DURING DOCKING

o CRITICALITY AND RISK ASSESSMENT

- o LANDING GEAR - CRITICALITY I
- o INSULATION AND SHIELDING - CRITICALITY I
- o DROGUE MATING SURFACE - CRITICALITY III
- o RISK IS ASSESSED TO BE MINOR
- o NO PHYSICAL DAMAGE TO ANY SURFACE HAS
BEEN REPORTED BY CREW

&

SCHEDULED VERIFICATION TESTS

- o INSPECTION DURING STATION KEEPING
- o NONE SPECIFIED IN FLIGHT PLAN HOWEVER
INSPECTION IS NORMAL PROCEDURE
- o NONE SPECIFIED IN FLIGHT PLAN

RATIONALE CLARIFYING NEED

- o RECOMMENDED TO VERIFY THAT INSPECTABLE
AREAS OF MICROMETEOROID SHIELDING AND
THERMAL INSULATION WERE NOT DAMAGED
BY POWER TRANSIENT
- o INSPECTION REQUIREMENT NOT JUSTIFIED
 - o LM FLOODLIGHT SWITCH FAILURE NOT
CORRELATABLE WITH DROGUE SURFACE
DAMAGE
 - o SWITCH IS MOUNTED ON SECONDARY
STRUCTURE
 - o IMPACT FROM DOCKING HAS MINOR EFFECT
ON SWITCH, IF ANY.
 - o MAJOR LOADS ON SWITCH RESULT FROM
VIBRATION DURING BOOST
 - o CREW REPORTED SMALL MARK INDICATING
NOMINAL CONTACT

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV 18, 1969

BY: C.T.GOLDEN

o SUBSYSTEM - STRUCTURES

o DISCREPANCIES

o F241 - ELECTRICAL POWER TRANSIENTS DURING BOOST

o CONCERN:

- o EFFECT OF POWER TRANSIENTS ON LM LANDING GEAR STRUCTURE
- o EFFECT OF POWER TRANSIENTS ON LM EXTERNAL THERMAL INSULATION AND MICROMETEOROID SHIELDING

o F245 - LM FLOODLIGHT SWITCH FAILURE

o CONCERN:

- o DEFORMATION OF SWITCH MOUNTING STRUCTURE MAY HAVE RESULTED FROM IMPACT LOADING DURING LM/CSM DOCKING. THIS CONCERN WAS DROPPED AFTER A REVIEW OF THE CONFIGURATION OF THE STRUCTURE.

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: A.C.OSBORNE

o SUBSYSTEM - CSM ELECTRICAL POWER AND SEQUENTIAL EVENTS CONTROL SUBSYSTEMS

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

- o INVERTERS (3)
- o AC POWER CONTROL BOX (1)
- o DC POWER CONTROL BOX (1)
- o INVERTER MOTOR SWITCH ASSY (1)
- o MAIN CB PANEL (1)
- o P.F. CORRECTION BOX (1)
- o SM POWER DISTRIBUTION BOX (1)
- o REACTION CONTROL SYSTEM CONTROLLER (1)
- o CIRCUIT UTILIZATION PANEL (1)
- o BATTERY CB PANEL (1)
- o SERVICE MODULE JETTISON CONTROLLER (2)
- o PYRO CONTINUITY VERIFICATION BOX (1)
- o LUNAR DOCKING EVENTS CONTROLLER (2)
- o MASTER EVENTS SEQUENCE CONTROLLER (2)
- o EARTH LANDING SYSTEM CONTROLLER (2)
- o FUSE BOX ASSEMBLY (1)

- o ALL EPS ELEMENTS ARE VERIFIED BY NORMAL OPERATION. ALL SECS ELEMENTS HAVE BEEN VERIFIED TO THE EXTENT POSSIBLE SHORT OF ACTUAL PERFORMING FUNCTION.

o ADDITIONAL TESTS

RATIONALE CLARIFYING NEED

- o VISUAL CHECK OF CSM FOR LIGHTNING DAMAGE BY LM CREW FOLLOWING CSM/LM SEPARATION, IF FLIGHT CONSTRAINTS PERMIT.

- o DATA OBTAINED FROM SUCH A CHECK TO BE USED IN ANALYSIS OF THE VEHICLE STATIC DISCHARGE PHENOMENA WHICH OCCURRED FOLLOWING LIFT OFF.

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: A.C.OSBORNE

- o CRITICALITY & RISK ASSESSMENT (IF NOT ADDITIONALLY TESTED)
 - o SM DEADFACE CONNECTOR (CRITICALITY III) AND SMJC CONTROLLED -X TRANSLATION & ROLL FUNCTION (CRITICALITY I) ARE THE ONLY EPS/SECS FUNCTIONS THROUGH CM/SM UMBILICAL THAT CANNOT BE VERIFIED BY NORMAL MISSION OPERATION OR TESTS PRIOR TO EARTH RE-ENTRY.
 - o SM DEADFACE AND SMJC WERE OPEN-LOOP AT ANOMALY PERIOD - OTHER OPEN-LOOP COMPONENTS IN SAME VICINITY SURVIVED.
 - o ONLY ANOMALOUS BEHAVIOR WAS ASSOCIATED WITH F/C DISCONNECT, WHICH WAS CLOSED-LOOP (THROUGH SCR) AT ANOMALY PERIOD, YET SURVIVED.
 - o NO INDICATIONS OF INADVERTENT OPERATION OF SM DEADFACE OR SMJC.
 - o NO ADDITIONAL RISK IN CONTINUING MISSION.
- o DISCREPANCIES
 - o F241 ELECTRICAL POWER TRANSIENTS DURING BOOST

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: G.F.BOWLING, JR

o SUBSYSTEM - LM REACTION CONTROL SYSTEM

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

PRESSURE INTEGRITY
PRESSURIZATION
ENGINE OPERATION

TELEMETRY READOUTS ACCEPTABLE
TO BE OPERATED AND CHECKED BEFORE SEP
TO BE OPERATED AND CHECKED BEFORE SEP

o ADDITIONAL TESTS

RATIONALE CLARIFYING NEED

NONE

o CRITICALITY OF RISK ASSESSMENT

o SM RCS USES IDENTICAL ENGINE ON OUTER SKIN

- WORSE EXPOSURE TO EMP
- NO INDICATION OF DAMAGE

o SYSTEM OPERATION VERIFIED BEFORE SEP

o FLIGHT DISCREPANCIES

o F252 LM RCS QUAD TEMP HIGH - SOLAR HEATING BEFORE PTC - NO PROBLEM

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: G.F. BOWLING, JR.

o SUBSYSTEM - DESCENT PROPULSION SYSTEM

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

o PRESSURE INTEGRITY

TELEMETRY READOUTS ACCEPTABLE

o PRESSURIZATION

TO BE OPERATED AND CHECKED BEFORE SEP

o ENGINE OPERATION

AT IGNITION

o ADDITIONAL TESTS

RATIONALE CLARIFYING NEED

NONE

o CRITICALITY/RISK ASSESSMENT

o NO INDICATION OF POTENTIAL DAMAGE FROM OPERATION OF SIMILAR EQUIPMENT (i.e. SPS)

o IF ENGINE DOES NOT OPERATE PROPERLY, REDOCK WITH RCS

o FLIGHT DISCREPANCIES

o NONE

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: G.F. BOWLING, JR

o SUBSYSTEM - LM ASCENT PROPULSION SYSTEM

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

PRESSURE INTEGRITY

TELEMETRY READOUTS ACCEPTABLE

PRESSURIZATION

NONE BEFORE FUNCTION

ENGINE OPERATION

NONE BEFORE FUNCTION

o ADDITIONAL TESTS

RATIONALE CLARIFYING NEED

o NONE

o CRITICALITY/RISK ASSESSMENT

o NO INDICATION OF POTENTIAL DAMAGE FROM OPERATION OF SIMILAR EQUIPMENT
PRIOR TO COMMITTING TO LANDING (i.e. SPS & DPS)

o FLIGHT DISCREPANCIES

o NONE

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: G.F. BOWLING, JR.

o SUBSYSTEM - ENVIRONMENTAL CONTROL SYSTEM

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

- o HEAT TRANSPORT SYSTEM
- o OXYGEN SUPPLY & PRESSURIZATION
- o WASTE MANAGEMENT
- o ATMOSPHERIC REVITALIZATION

- o TELEMETRY CHECKS O.K. DURING LM C/O AFTER TLI
- o OPERATIONAL C/O BEFORE SEPARATION

o ADDITIONAL TESTS

RATIONALE CLARIFYING NEED

- o NONE

o CRITICALITY/RISK ASSESSMENT (IF NOT ADDITIONALLY TESTED)

- o NO INDICATION OF POTENTIAL DAMAGE FROM OPERATION OF LMECS OR SIMILAR EQUIPMENT IN CSM

o FLIGHT DISCREPANCIES

- o NONE

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: G.F. BOWLING, JR.

o SUBSYSTEM - EXPLOSIVE DEVICES

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

- o LM SLA SEP
- o LDG GEAR DEPLOYMENT
- o LM RCS PRESSURIZATION
- o LM DPS
 - HELIUM
 - COMPATIBILITY VALVE
 - AMBIENT START VALVE
 - LUNAR DUMP VALVE
- o LM SEPARATION
- o LM APS
 - HELIUM
 - COMPATIBILITY VALVE

- o INDICATED ED's ARE OPERATED PRIOR TO SEPARATION

o ADDITIONAL TESTS

RATIONALE CLARIFYING NEED

- o NONE

o CRITICALITY/RISK ASSESSMENT

- o NO INDICATION OF POTENTIAL DAMAGE FROM OPERATION OF SIMILAR EQUIPMENT BEFORE COMMITTING TO DESCENT - i.e. CSM & PRE-DOI LM ORDNANCE
- o CIRCUITRY TWISTED - SHIELDED PAIR LEADS - PROTECTED FOR EMP
- o SBASI PROTECTED FOR EMP BY INTERNAL SPARK GAP
- o PROBABLE DAMAGE FROM PULSE IS TO "FIRE" AND NOT TO "DUD"

o FLIGHT DISCREPANCIES - NONE

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: G.F. BOWLING, JR.

o SUBSYSTEM - BATTERIES

o ESSENTIAL ELEMENTS

- o DESCENT
- o ASCENT
- o PYRO

&

SCHEDULED VERIFICATION TESTS

- o TELEMETRY CHECKS O.K. DURING LM C/O AFTER TLI.
- o OPEN CIRCUIT VOLTAGE
- o LOADED VOLTAGE & CURRENT FOR DESCENT AND ASCENT
- o OPERATIONAL C/O BEFORE SEPARATION

o ADDITIONAL TESTS

- o NONE

RATIONALE CLARIFYING NEED

o CRITICALITY/RISK ASSESSMENT

- o NO INDICATION OF BATTERY DAMAGE IN CSM OR LM TO DATE.

o FLIGHT DISCREPANCIES

- o NONE

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: A.C.OSBORNE
(R.R.OLSON)

o SUBSYSTEM - LM ELECTRICAL POWER DISTRIBUTION

o	<u>ESSENTIAL ELEMENTS</u>	&	GET	<u>SCHEDULED VERIFICATION TESTS</u>
	2 ASCENT & 2 DESCENT ELECTRICAL CONTROL ASSEMBLIES (ECA)		03:23	CSM APPROACH TO DOCK - DOCKING LIGHTS ASSURE D/S LV AND LCA OPERABLE
	1 RELAY JUNCTION BOX (RJB)		03:50	CSM/LM UMBILICAL CONNECTION AND
	1 DEADFACE RELAY (DFR)		04:07	LM/SLA SEPARATION ASSURES CSM/SLA PYRO
	2 DISTRIBUTION PANELS:		03:50	TRANSFER LM TO CM POWER ASSURES
	CDR'S NO. 11, LMP'S NO. 16		04:15	UMBILICAL VALIDITY, D/SECA & PNL 11 OPERATION
	1 POWER CONTROL PANEL: LMP'S NO.14		90:30	COMMUNICATIONS VERIFICATION: D/S ECA's RJB, DFR, PANELS 11, 14 & 16. GPI SUPPORT
	2 DC TO 400 HZ INVERTERS (GPI)		104:00	TRANSFER TO LM POWER & CHECK ALL SYSTEMS
	2 EXPLOSIVE DEVICES RELAY BOXES (EDRB)			VERIFIES ALL EPS FUNCTIONS EXCEPT EDRB
	1 LIGHTING CONTROL ASSEMBLY (LCA)		105:46	DEPLOY LANDING GEAR
			106:23	RCS PRESSURIZATION
			107:35	DPS PRESSURIZATION
				ASSURE ALL EDRB FUNCTIONS POSSIBLE

o	<u>ADDITIONALS TESTS</u>	&	<u>RATIONALE CLARIFYING NEED</u>
	NONE		NONE

o CRITICALITY & RISK ASSESSMENT (IF NOT ADDITIONALLY TESTED)

NO RISKS, NOT ASSESSED PRE-FLIGHT, HAVE BEEN IDENTIFIED

o DISCREPANCIES

NO EPS DISCREPANCIES TO GET 102:00

TELECON CHART

TITLE
APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV 18, 1969

BY: A.C. OSBORNE

o SUBSYSTEM: LM COMMUNICATIONS

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

- o S-BAND XCVR's, PA's, & ANTENNAS
- o VHF XCVR's, ANTENNAS
- o DIGITAL UPLINK ASSEMBLY
- o SIGNAL PROCESSOR ASSEMBLY
- o PCM-TLM

- ALL ESSENTIAL LM COMMUNICATION EQUIPMENT
- WAS VERIFIED AT 90:30 GET. WITH THE EXCEPTION
- OF THE S-BAND STEERABLE ANTENNA. THE STEERABLE
- WILL NOT BE UTILIZED UNTIL LM-IVT (104:05 GET).

o ADDITIONAL TESTS

&

RATIONALE CLARIFYING NEED

- o NONE

o CRITICALITY & RISK ASSESSMENT (IF NOT ADDITIONALLY TESTED)

- o ALL ELEMENTS VERIFIED, CRITICALITY II.

o DISCREPANCIES

- o NONE REPORTED TO DATE.

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV 18, 1969

BY: A.C.OSBORNE

o SUBSYSTEM: CSM COMMUNICATIONS

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

- o S-BAND XCVR's, PA's, & ANTENNAS
- o VHF XCVR's & ANTENNAS
- o PMP/AUDIO CENTER
- o UPDATA LINK EQUIPMENT
- o PCM-TLM

- ALL ESSENTIAL CSM COMMUNICATION EQUIPMENTS
- HAS BEEN SATISFACTORILY VERIFIED. NO
- SIGNIFICANT HARDWARE ANOMALIES HAVE BEEN
- REPORTED SUBSEQUENT TO LIFT-OFF.

o ADDITIONAL TESTS

&

RATIONALE CLARIFYING NEED

- o NONE

o CRITICALITY & RISK ASSESSMENT (IF NOT ADDITIONALLY TESTED)

- o ALL ELEMENTS VERIFIED, CRITICALITY III. EXCEPT PCM - TLM, WHICH IS CRITICALITY II

o DISCREPANCIES

- o AT APPROXIMATELY 84:32 GET AFTER TV BUT PRIOR TO LOS THE GROUND STATION REPORTED A VARIATION IN COMMUNICATION SIGNAL STRENGTH. UNKNOWN AT THIS TIME IF DISCREPANCY IS SPACECRAFT OR GROUND STATION PROBLEM; HOWEVER, GOOD COMMUNICATION HAS BEEN VERIFIED SINCE THIS DISCREPANCY WAS REPORTED. THIS DISCREPANCY IS STILL UNDER INVESTIGATION.

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: A.C.OSBORNE

o SUBSYSTEM: RADAR

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

o RENDEZVOUS RADAR

-

SELF-TEST IS SCHEDULED FOR 107:00 GET. THIS TEST ADEQUATELY VERIFIES THE OPERATIONAL CAPABILITY OF THE RR AND RR ANTENNA.

o VHF RANGING

-

CHECKED BY CORRELATION OF RR AND VHF RANGE INFORMATION.

o TRANSPONDER

-

SELF-TEST WAS SUCCESSFULLY PERFORMED AT 79:36 GET. ANOTHER XPNDR SELF-TEST IS SCHEDULED FOR 107:25 GET. THIS TEST ADEQUATELY VERIFIES XPNDR OPERATION.

o LANDING RADAR

-

SELF-TEST IS SCHEDULED FOR 108:05 GET. THIS TEST ADEQUATELY VERIFIES OPERATION OF THE LR AND LR ANTENNA REPOSITIONING CAPABILITY.

o ADDITIONAL TESTS

&

RATIONALE CLARIFYING NEED

NONE

o CRITICALITY & RISK ASSESSMENT (IF NOT ADDITIONALLY TESTED)

CRITICALITY II. NO ADDITIONAL RISK.

o DISCREPANCIES

NONE

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: A.C.OSBORNE

o SUBSYSTEM - LM INSTRUMENTATION

o ESSENTIAL ELEMENTS

&

SCHEDULED VERIFICATION TESTS

SIGNAL CONDITIONING ELECTRONICS
ASSY (SCEA)

FUNCTIONAL VERIFICATION

DATA STORAGE ELECTRONICS ASSY
(DSEA)

90:30 - 91:00 GET

CAUTION & WARNING ELECTRONICS
(CWEA)

COMPLETE

o ADDITIONAL TESTS

&

RATIONALE CLARIFYING NEED

NONE

o CRITICALITY & RISK ASSESSMENT (IF NOT ADDITIONALLY TESTED)

NONE

o DISCREPANCIES

F-245 LM FLOODLIGHT SWITCH FAILURE - CRITICALITY III
(APPROX. 10:20 GET)

TELECON CHART	TITLE APOLLO 12 PRE-DOI ASSESSMENT RELATIVE TO EXISTING FLIGHT DISCREPANCIES	DATE: <u>11/18/69</u> BY: <u>A. C. OSBORNE</u>
LM GN&C SUBSYSTEM		
<u>ESSENTIAL ELEMENTS</u> IMU LGC DSKY ASA AEA DEDA DECA RGA GDA ACA TTCA ATCA	&	<u>SCHEDULED VERIFICATION TESTS</u> OPERATIONAL, DRIFT & BIAS DURING PRE-UNDOCK C/O SELF TEST & E-MEMORY DUMP DONE FRIDAY OPERATIONAL DURING PRE-UNDOCK C/O SELF TEST & LAMP CHECK DONE FRIDAY OPERATIONAL DURING PRE-UNDOCK C/O OPERATIONAL, DRIFT & BIAS DURING PRE-UNDOCK C/O OPERATIONAL DURING PRE-UNDOCK C/O OPERATIONAL DURING PRE-UNDOCK C/O OPERATIONAL DURING PRE-UNDOCK C/O EXCEPT ENGINE ON/OFF CIRCUITS OPERATIONAL DURING PRE-UNDOCK C/O OPERATIONAL DURING PRE-UNDOCK C/O OPERATIONAL DURING PRE-UNDOCK C/O OPERATIONAL DURING PRE-UNDOCK C/O OPERATIONAL DURING PRE-UNDOCK C/O
<u>ADDITIONAL TESTS</u> NONE	&	<u>RATIONALE CLARIFYING NEED</u> PRE-UNDOCK TESTS ARE AS COMPREHENSIVE AS POSSIBLE
<u>DISCREPANCIES</u> NONE		

TELECON CHART

TITLE

APOLLO 12 PRE-DOI ASSESSMENT
RELATIVE TO EXISTING FLIGHT DISCREPANCIES

DATE: NOV. 18, 1969

BY: A. C. OSBORNE

o SUBSYSTEM - LM D&C

o ESSENTIAL ELEMENTS

VARIOUS SUBSYSTEM ASSOCIATED
INDICATORS AND SWITCHES

&

SCHEDULED VERIFICATION TESTS

INSTRUMENTATION CONTROL VERIFIED 90:30 GET.
ECS CONTROL VERIFIED AT 90:30 GET.

POWER TRANSFER CAPABILITY VERIFIED 90:30 GET.
COMM CONTROL CAPABILITY VERIFIED 90:30 GET.
REMAINDER TO BE VERIFIED DURING SUBSYSTEM
CHECKOUT STARTING AT 104:00 GET.

o ADDITIONAL TESTS

&

RATIONALE CLARIFYING NEED

NONE

o CRITICALITY & RISK ASSESSMENT (IF NOT ADDITIONALLY TESTED)

CRITICALITY 1, 2 OR 3 DEPENDING ON USAGE. THERE IS MINIMAL RISK BECAUSE:

- o PORTION OF SUBSYSTEM OPERATED SO FAR HAS PERFORMED SATISFACTORILY
- o MOST OF SUBSYSTEM WAS NOT POWERED AT TIME OF STATIC DISCHARGE
- o SIMILAR CSM COMPONENTS HAVE OPERATED SATISFACTORILY

o DISCREPANCIES

NONE

TELECON CHART**TITLE**

LIGHTNING PROTECTION BONDING
NR SPEC. MA0305-0055

DATE: 11/18/69**BY:** W. J. WAUGH

- o REQUIREMENT - BONDING SYSTEM
 - o TO PREVENT DAMAGE FROM LIGHTNING DISCHARGE CURRENT EXTERNALLY
 - o TO ELIMINATE INDUCTION OF HIGH VOLTAGES INTERNALLY
- o LIGHTNING CURRENT SURGES MAY EXCEED 100,000 AMPERES PEAK
- o OTHER HIGH POTENTIALS MAY RESULT FROM SPACECRAFT PROPULSION SYSTEMS AND PASSAGE OF CRAFT THROUGH LAYERS ACTIVATED BY SPACE RADIATION.
- o INDIVIDUAL BONDING JUMPERS FOR LIGHTNING PROTECTION
 - o NOT LESS THAN 6,475 CIRCULAR MILS TINNED COPPER-STRANDED CABLE
 - o NOT LESS THAN 10,000 CIRCULAR MILS STRANDED ALUMINUM CABLE
- o MINIMUM CONTACT RESISTANCE
- o CLOSE-RIVETED SKIN CONSTRUCTION EQUIVALENT TO JUMPERS FOR LIGHTNING DISCHARGE PATH

TELECON CHART

TITLE

DATE: 11/18/69

BONDING
LM SPECS LSP-520-001B, LSP 530-001

BY: W. J. WAUGH

- o LIGHTNING NOT MENTIONED IN GEN. SPEC. FOR EMI CONTROL REQUIREMENTS (LSP 520-001B)
- o REQUIREMENT - BONDING
 - o ONLY PROVISIONS IN DESIGN OF EQUIPMENT AND SPECIFIED IN INSTALLATION INSTRUCTIONS SHALL BE USED TO BOND UNITS, SUCH AS EQUIPMENT CASE AND MOUNT, TOGETHER OR TO THE GROUND PLANE.
 - o BONDING STRAPS USED FOR TEST SETUPS SHALL HAVE:
 - o LENGTH NOT GREATER THAN FIVE TIMES THE WIDTH
 - o COPPER OR BRASS METAL STRIPS, NOT BRAID
 - o CLEAN METAL TO METAL CONTACT
- o REQUIREMENT - GROUNDING SYSTEM
 - o SINGLE POINT GROUND SCHEME FOR ALL CIRCUITS AND CIRCUIT SHIELDS HAVING SIGNIFICANT FREQUENCY COMPONENTS OF 50 KC AND LOWER
 - o MULTIPLE POINT GROUND SCHEME FOR CIRCUITS AND SHIELDS OPERATING AT OR HAVING SIGNIFICANT FREQUENCY COMPONENTS ABOVE 50 KC.

TELECON CHART

F241

TITLE

ELECTRICAL POWER TRANSIENTS DURING BOOST (CSM)

DATE: NOV. 17, 1969

BY: W.J. WAUGH

LES/CM = 4 BOLTS

CM/SM* = 3 TENSION TIES,
UMBILICAL - 7 HARDLINES (PLUMBING)
TO COAX CABLES, HINGED BOOM

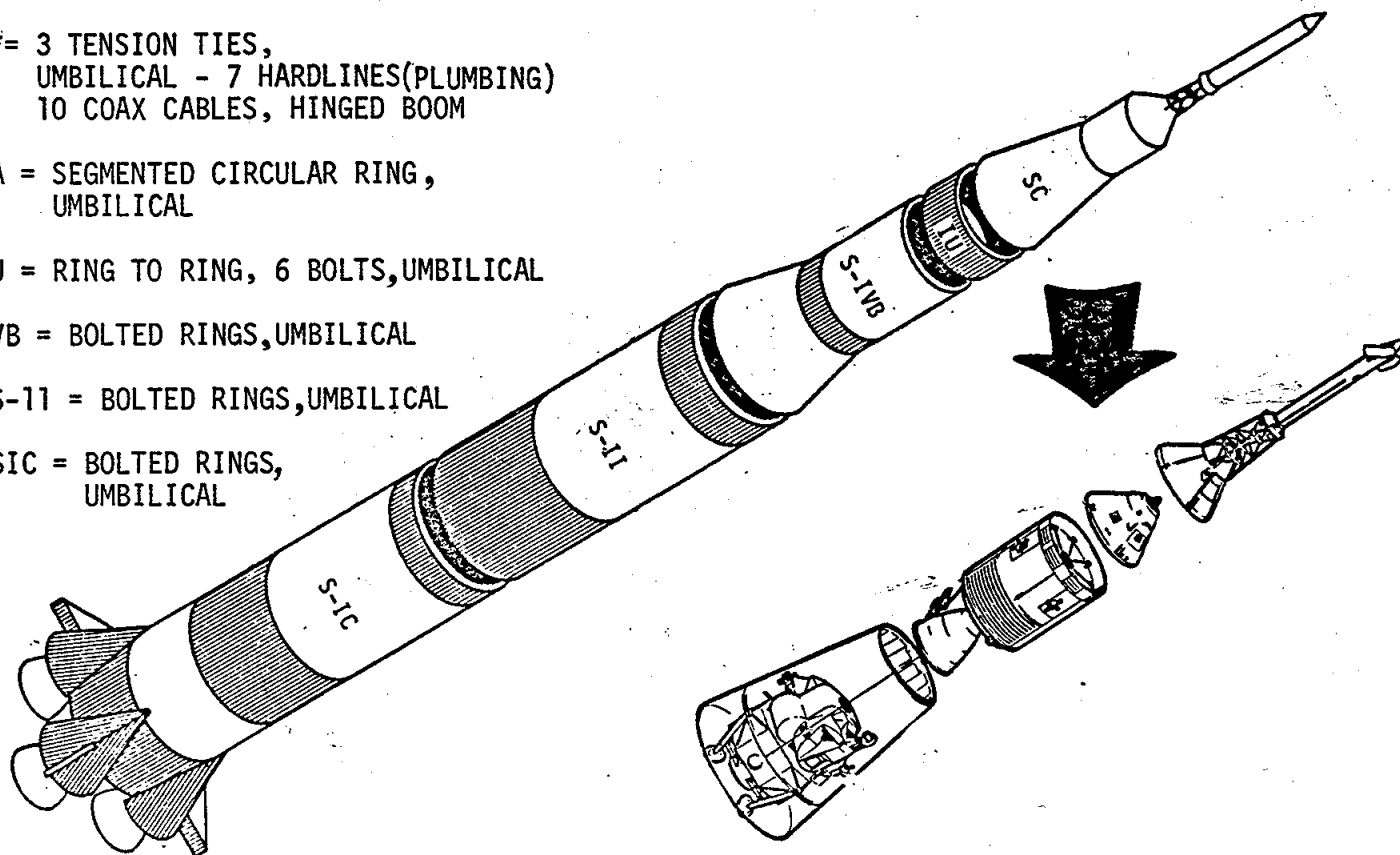
SM/SLA = SEGMENTED CIRCULAR RING,
UMBILICAL

SLA/IU = RING TO RING, 6 BOLTS, UMBILICAL

IU/SIVB = BOLTED RINGS, UMBILICAL

SIVB/S-11 = BOLTED RINGS, UMBILICAL

S-11/SIC = BOLTED RINGS,
UMBILICAL



MA0305-0055 NR Spec.

* INDIVIDUAL BONDING JUMPERS FOR LIGHTNING PROTECTION SHALL BE EQUIVALENT #12 AWG TINNED
COPPER-STRANDED WIRE

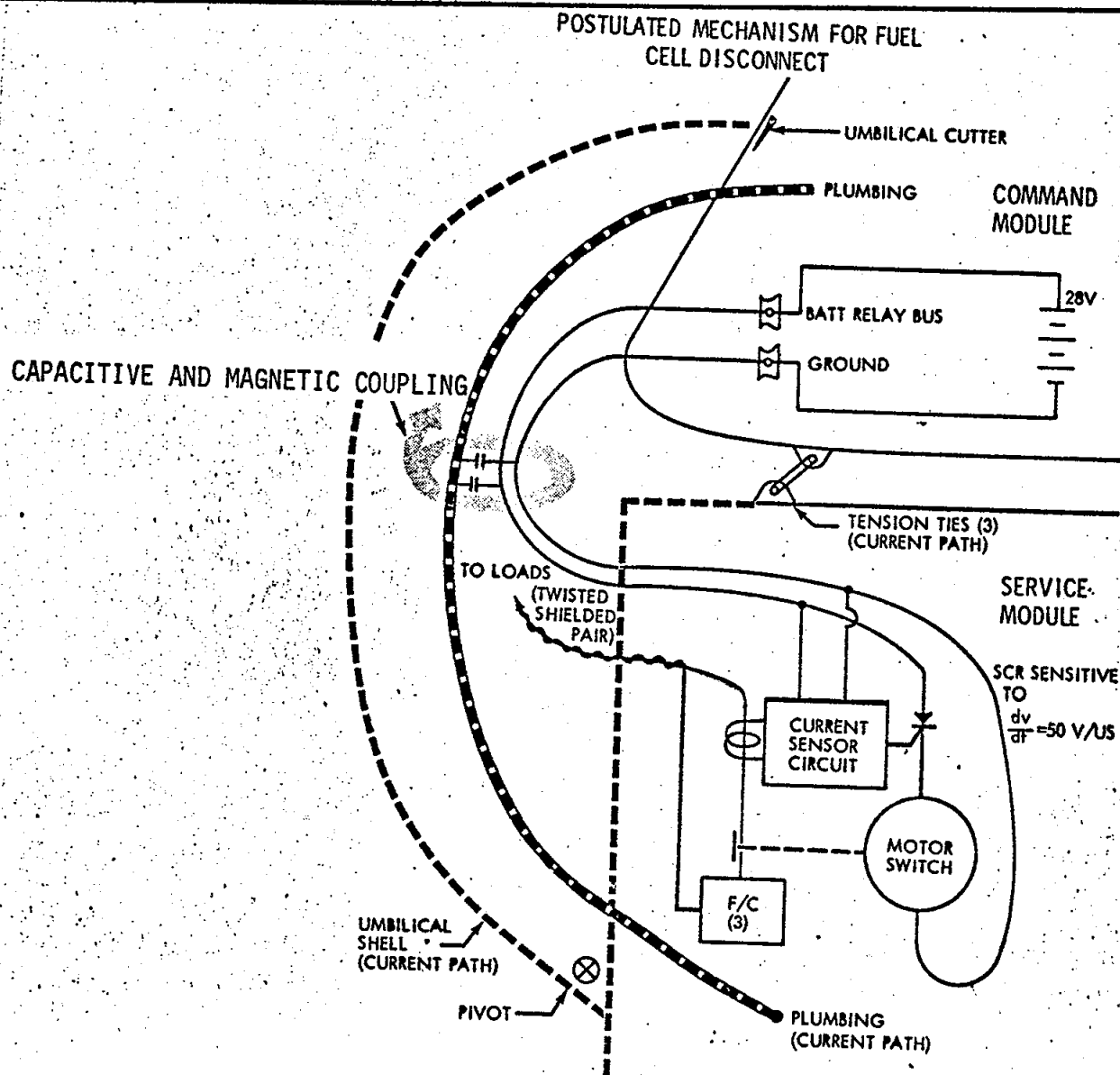
TELECON CHART

TITLE

ELECTRICAL POWER TRANSIENTS DURING BOOST

DATE: NOV. 18, 1969

BY: A.C. OSBORNE



TELECON CHART

TITLE

APOLLO 12 - ELECTRICAL POWER TRANSIENTS DURING BOOST

REVIEW OUTLINE

DATE: NOV. 20, 1969

BY: W. J. WAUGH

- o ATMOSPHERIC ENVIRONMENT AT LAUNCH
 - o TEMP GRADIENT - SEA LEVEL TO 10 KM
 - o WIND PROFILE - SEA LEVEL TO 10 KM
 - o VOLTAGE GRADIENT - SWEENEY READINGS (T-10 MIN TO T+10 MIN)
 - o CLOUD COVER VERTICAL CROSSSECTION
 - o RAIN PROFILE T-60 MIN TO LAUNCH
 - o LIGHTNING STRIKES T-0 TO T+60 SEC
 - o THUNDER CLAPS T-0 TO T+60 SEC.
- o FLIGHT PROFILE
 - o TIME - T-0 TO T+60 SECONDS
 - o ALTITUDE VS. TIME
 - o VELOCITY VS. TIME
 - o ONBOARD ACOUSTICS VS. TIME
 - o PHOTOS
 - o PLUME CONDUCTIVITY

TELECON CHART

TITLE

APOLLO 12 - ELECTRICAL POWER TRANSIENTS DURING BOOST

REVIEW OUTLINE

DATE: NOV. 17, 1969

BY: W. J. WAUGH

- o ATMOSPHERIC ENVIRONMENT
 - o TIME - T-30 MINUTES TO T+30 MINUTES
 - o TEMP GRADIENT - SEA LEVEL TO 10 KM
 - o PRESSURE GRADIENT - SEA LEVEL TO 10 KM
 - o VOLTAGE GRADIENT - SEA LEVEL TO 10 KM
- o FLIGHT PROFILE
 - o TIME - T-0 TO T+60 SECONDS
 - o ALTITUDE VS. TIME
 - o VELOCITY VS. TIME

TELECON CHART

TITLE

ATMOSPHERIC ELECTRICAL PHENOMENA
REVIEW OUTLINE

DATE: NOV. 17, 1969

BY: W. J. WAUGH

o FORMS

o SHEET LIGHTNING

- AREA DISCHARGE
- HOMOGENUOUS
- PERSISTENT
- OCCURS BETWEEN UPPER AND LOWER ATMOSPHERE

o STREAK LIGHTNING

- STROKE
- SHORT DURATION
- OCCURS CLOUD TO EARTH AND CLOUD TO CLOUD
- NORMALLY OBSERVED FORM

o OTHERS

- RIBBON
- BEAD
- HEAT
- FORK
- GLOBULAR (BALL)

Attachment 3
5-2700-HOU-356
Page 2 of 7

TELECON CHART

TITLE

DATE: NOV. 17, 1969

ATMOSPHERIC ELECTRICAL PHENOMENA

REVIEW OUTLINE

BY: W. J. WAUGH

o EFFECTS

o THUNDER

o PRESSURE WAVES DEVELOPED

- HEAT
- DISASSOCIATION
- IONIZATION

o COMPARISON TO SONIC BOOM

- AIRCRAFT VS. SHOCKWAVE PENETRATION

o ON AIRCRAFT

o FLOW

- WING TIP TO WING TIP
- NOSE TO TAIL
- NOSE STREAMERS
- USUALLY CLOUD TO CLOUD
- LOW CURRENT

o DAMAGE TYPES

- MINOR SKIN DAMAGE
- MAGNETIC COMPASSES
- RADIO EQUIPMENT

TELECON CHART

TITLE

ATMOSPHERIC ELECTRICAL PHENOMENA

REVIEW OUTLINE

DATE: NOV. 17, 1969

BY: W. J. WAUGH

o EFFECTS (CONTINUED)

o ON AIRCRAFT

o SUSCEPTIBILITY INCREASES

- AS SIZE INCREASES
- AS SPEED INCREASES
- WITH TRAILING ANTENNAS
- NEAR 0°C

o NOT SUSCEPTIBLE BELOW -20°C

o DAMAGE MECHANISMS

- o PINCH EFFECT - TUBULAR CRUSH - CURRENT PEAKING
- o THERMAL - CONTINUING CURRENTS
- o EXPLOSIVE - NON CONDUCTORS

TELECON CHART

TITLE

ATMOSPHERIC ELECTRICAL PHENOMENA
REVIEW OUTLINEDATE: NOV. 17, 1969BY: W. J. WAUGH

- o GENERATION OF POTENTIAL DIFFERENCES
 - o RAIN, ICE CRYSTALS and snow
 - o EARTH USUALLY POSITIVE
 - o LOWER CLOUD - NEGATIVE
 - o UPPER CLOUD - POSITIVE
- o DISCHARGE DATA
 - o STROKE DURATION: .0003 TO 1.6 SEC (.01 SEC AVG)
 - o CHARGE: 0+ TO 300 COULOMBS (18 AVERAGE)
 - o POLARITY: PREDOMINANTLY EARTH-POSITIVE, LOWER CLOUD-NEGATIVE
 - o PEAK CURRENTS: TO 200,000 AMPS
 - o DENSITY: APPROXIMATELY 1000 AMP/CM²
 - o RISE TIME: $> .1\mu$ SEC.
 - o PERSISTANCE: 10,000 AMP FOR 100μ SEC.

TELECON CHART

TITLE

ATMOSPHERIC ELECTRICAL PHENOMENA

REVIEW OUTLINE

DATE: NOV. 17, 1969

BY: W. J. WAUGH

- o VEHICLE ELECTRICAL SHIELDING CHARACTERISTICS
 - o DESIGN SPECIFICATIONS
 - o DESIGN - STRUCTURE SKETCH
 - o QUAL/DEVELOPMENT TESTING
 - o ACCEPTANCE TESTING
 - o LAUNCH PAD TESTING
 - o CONFIGURATION DIFFERENCES - APOLLO 11, 12 & 13
 - SHIELDING APERTURES AND WEAKNESSES
 - ESTIMATE CAPABILITY
- o SPACECRAFT SUSCEPTIBILITY
 - o EXTERNAL
 - PAINTS
 - DIELECTRICS
 - PROTUBERANCES
 - o INTERNAL
 - PYROTECHNICS
 - TRANSIENT THRESHOLDS
 - SEMI CONDUCTORS
 - o CONFIGURATION DIFFERENCES - APOLLO 11, 12 & 13

TELECON CHART

TITLE

ATMOSPHERIC ELECTRICAL PHENOMENA

REVIEW OUTLINE

DATE: NOV. 17, 1969

BY: W. J. WAUGH

- o SPACECRAFT ELECTRICAL/ELECTRONIC CONFIGURATIONS
 - o AT LAUNCH
 - o CHRONOLOGICALLY T-0 TO T+30 SECONDS
 - o REQUIRED CAPABILITY VS. AVAILABLE EQUIPMENT
- o FLIGHT FAILURES ATTRIBUTABLE TO ELECTRICAL DISCHARGE
 - o SPACECRAFT
 - o LAUNCH VEHICLE
- o POSSIBLE OTHER CAUSES
- o PREVIOUS PROGRAMS' EXPERIENCE
 - o MISSILE
 - o MERCURY AND GEMINI
 - o METAL AIRCRAFT
- o POSTULATE EXTERNAL VEHICLE CONDITIONS T-0 TO T-45 SECONDS
- o DEFINE LAUNCH RESTRICTIONS WITH PRESENT SHIELDING DESIGN
- o DEFINE DESIGN CHANGES TO REMOVE LIGHTNING AS A LAUNCH CONSTRAINT

USE BLACK
BALLPOINT
PEN

SPAN / MISSION EVALUATION ACTION REQUEST

USE BLACK
BALLPOINT
PEN

TIME
(T- MINUS/GET)

25 HRS

REQUEST
ORGANIZATION

FOD

RESPONSE
ORGANIZATION

B45

CONTROL
NUMBER

C-20

ACTION REQD BY (TIME): AS SOON AS PRACTICABLE REQUESTER: ALDRICH

SUBJECT:

RCS QUANTITY TRANSDUCERS

APPROVAL

PARAMETERS SR5025Q, SR5026Q, SR5027Q

AND SR5028Q WERE GLUTCHED DURING THE

LAUNCH PHASE ELECTRICAL ANOMALY. NONE

OF THESE READINGS HAVE BEEN VALID SINCE

THAT TIME NOR HAVE BEEN CREW

READOUTS OF THESE TRANSDUCERS THROUGH

THE RCS INDICATORS SW. WE WOULD

LIKE AN ANALYSIS PERFORMED WITH THE

OBJECTIVE OF DEFINING THE MOST LIKELY

FAILURE MODE OR MODES FOR THIS CASE.

HARD SHORTS TO POWER OR INDEPENDENT

UNRELATED FAILURES DO NOT SEEM TO BE

VERY PROBABLE.

FOD REP

TIME :

SPAN MGR

TIME :

25:08

RESPONSE:

SEE ATTACHED

CONCUR

TEAM LDR

TIME :

CON SR REP

TIME :

ME MGR

TIME :

SPAN MGR

TIME :

RESPONDER

TIME :

LOG MANAGER:

TIME :

FOD REP

SPAN MANAGER

TIME :

TIME :

SPAN/Mission Evaluation Action Request
RCS Quantity Transducers
Control Number C-20

The RCS P/T Quantity Transducers utilize semiconductor strain gages attached to a pressure sensitive diaphragm. These strain gages are comprised of doped silicon (semiconductor) and will fail to function correctly after being subjected to an over voltage transient (1 ma maximum or 450 millivolt maximum).

Experience in performing megger checks on these transducers in 1968 revealed that the semiconductor gages were subject to damage by an overvoltage condition (megger output of 100 volts). To protect the strain gages or the P/T's, a diode and transformer are used. Breakdown of the diode occurs at 14 volts and saturation of the transformer occurs at 20 ma.

Apparently, the reported vehicle electrical transient at T +36 was coupled through vehicle wiring to the diode and gages causing either diode or gages to fail (see attached NR report and drawings for details). Prior to L/O +36 seconds, two of the measurements were less than 5.0 volts, while after 36 seconds, all four measurements indicated full scale (5.0 volts) output and have remained so.

Figure 2 shows the location of the P/T sensors to be near the same plane in the service module as the sun sensors (SA 1830T, SA 1831T, SA 1832, SA 1833T) which failed at T +36 seconds.

Consideration was given to the 4 P/T measurements being on the same PCM signal gate but the fifth measurement CG 2300 (PIPA Temp) has remained at the same reading of near mid scale. If the signal gate failed -- all measurements would probably be the same full scale reading.

It is concluded that the probable cause of this flight anomaly was electrical overstress of the protective P/T diodes resulting in permanent failure of either these diodes and/or the semiconductor strain gages.

1577-

OLD INSTL
X) (REF)

M.C.

2

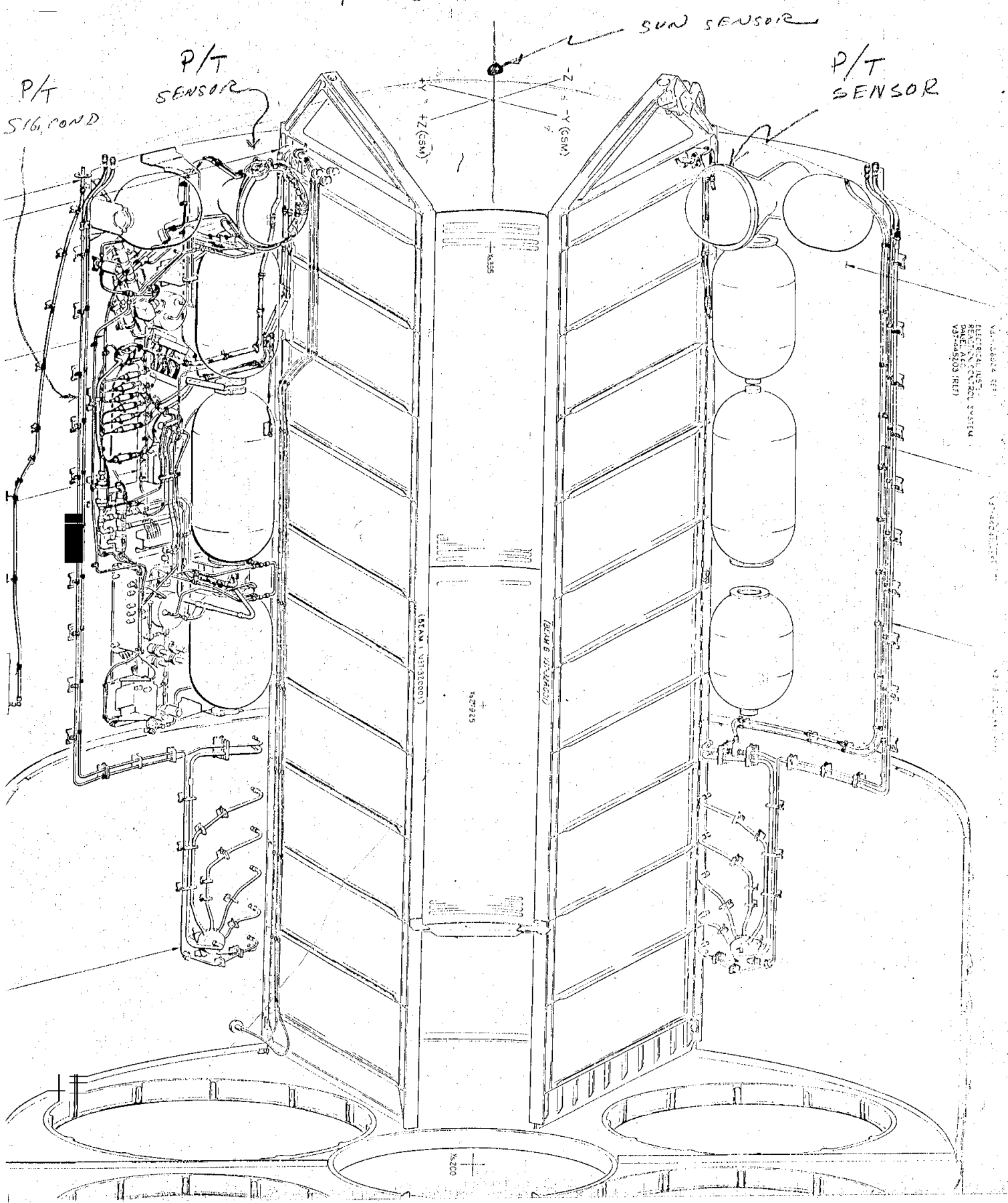
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 84

BLE INSTL-
F OMNI
IMITAR ANT
COAXIAL
7-710601 (REF)

-E INSTL-
 IAL SERVICE
 ULE TO GSE
 AWAY
 -710101 (REF)

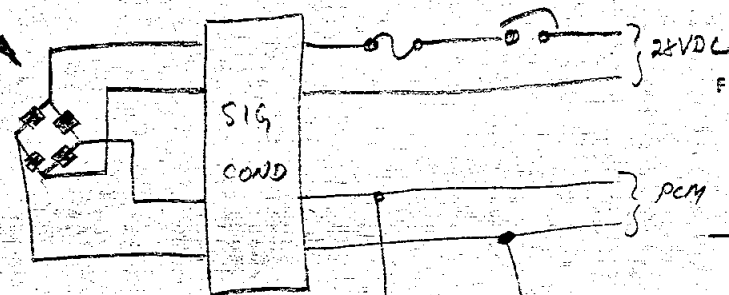
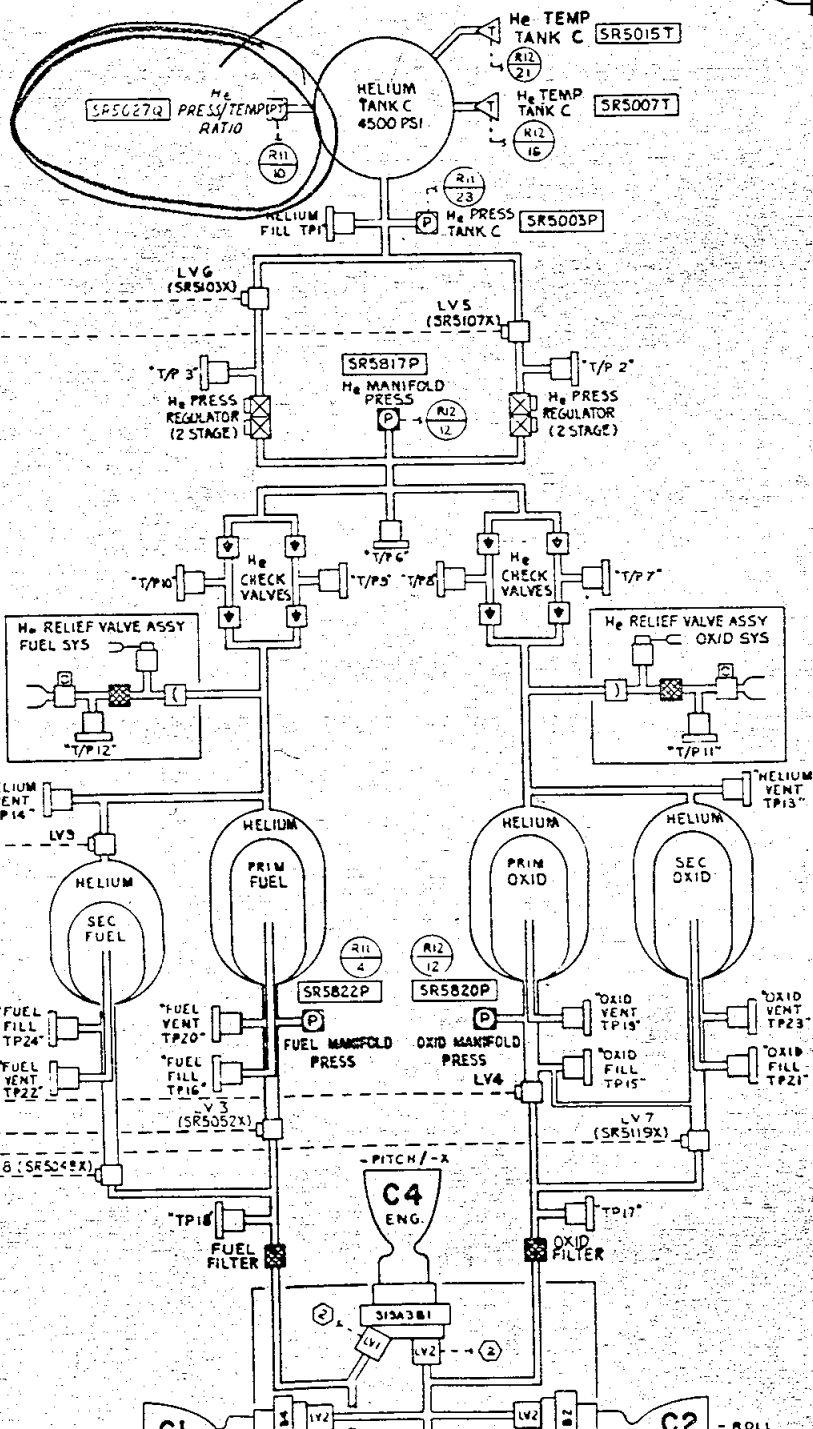
PANEL 5

FIG 2



YS200

SI9A3
QUAD C

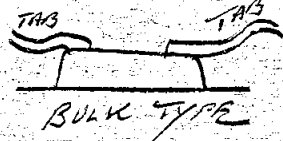
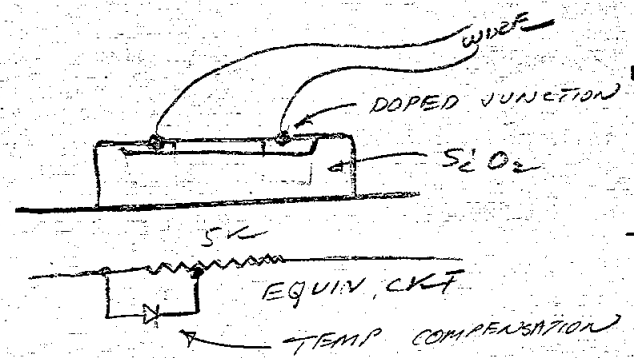


QUAD C

QUAD B

QUAD A

He TK TEMP



- ④ THESE MEAS FOR CSM 108 & SUBS. ONLY (ZONES 7, 8, & 20).
- ③ CSM 104 ONLY (ZONE 18).
- ② FOR ELECTRICAL ACTIVATION OF ENGINE VALVES LV1 AND LV2 SEE THE FOLLOWING:
DIRECT COILS → SHEETS R7 AND R8
NORMAL COILS → SHEETS R3 AND R10
- ① FOR CONTINUATION OF GSE CIRCUITS FOR THESE MEAS AND STIMULI SEE THE FOLLOWING SCHEMATICS:
G34 300101 DOWNEY BLDG 290
G34 306101 MSC MSOB
G34 308102 MSC LC39 VAB

LV34-900101 P

| | | | | | |
|---|----------------------|---|----------------|-------------------------|--|
| USE BLACK BALLPOINT PEN | | SPAN / MISSION EVALUATION ACTION REQUEST | | USE BLACK BALLPOINT PEN | |
| TIME
(T- MINUS/GET) | REQUEST ORGANIZATION | RESPONSE ORGANIZATION | CONTROL NUMBER | | |
| 24:10 | FOD | 4S | C-16 | | |
| ACTION REQD BY (TIME): | | | REQUESTER | | |
| 30:00 | | | FOD | | |
| SUBJECT: | | APPROVAL | | | |
| STATIC ELECTRICITY THEORY
PLEASE DOCUMENT THE STATIC
ELECTRICITY THEORY THAT WAS
DISCUSSED
PRESENTED TO K24T / MCDIV. IT ON
11/14/69 AFTER THE LAUNCH PHASE | | FOD REP | | | |
| | | Roach | | | |
| | | TIME 24:10 | | | |
| | | SPAN MGR | | | |
| | | TIME 4:11 | | | |
| | | | | | |
| RESPONSE: | | AFTER OVERCOMING an electrical failure, which was not fully understood several hours after the launch, Apollo 12 was sailing smoothly toward man's second attempt at a moon landing.

A possibility, which officials here discounted, was that the spacecraft or launch rocket was struck by lightning, as Conrad, the Apollo 12 commander, conjectured.

Ground controllers at MSC, however, later decided that what Conrad thought was lightning probably was a gigantic burst of static electricity. | | CONCUR | |
| | | TEAM LDR | | | |
| | | TIME : | | | |
| | | CON SR REP | | | |
| | | TIME : | | | |
| | | ME MGR | | | |
| | | SPAN MGR | | | |
| | | TIME : | | | |
| | | TIME : | | | |
| | | TIME : | | | |
| | | TIME : | | | |
| | | | | | |
| RESPONDER | | LOG MANAGER: | | | |
| TIME : | | TIME : | | | |
| FOD REP | | SPAN MANAGER | | | |
| TIME : | | TIME : | | | |

